ANATOMY AND PHYSIOLOGY

SYLLABUS FOR COMMUNITY COLLEGES

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This syllabus includes both lecture notes and laboratory activities for a two-semester anatomy and physiology community college course. The syllabus is based on a 16-week semester that is comprised of a three-hour lecture section and a one-hour laboratory class each week. Both the lecture course and laboratory are necessary to fulfill the requirement for anatomy and physiology. Laboratory activities coincide with lectures to enhance understanding of each topic by providing visual and hands-on experiments for the concepts learned in the lecture. Laboratory quizzes will be given each week to help students maintain a working knowledge of the material learned in the laboratory. This course is appropriate for the typical anatomy and physiology student and should benefit both students who plan to major in biology and also those who are non-biology majors. Because subject matter in anatomy and physiology is quite difficult, the importance of attendance and good study skills is stressed.

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Anatomy and Physiology I
Course Syllabus

Anatomy and Physiology provides a general overview and introduction to the human body. The content in the course examines each of the body systems, and how they function together to maintain proper body functioning.

Because the content of this course is difficult, attendance is crucial. A student manual will be available to guide you in taking notes. There will be three examinations, and a non-comprehensive final. The exams have equal weight in determining the semester grade.

Exam I	=	100 pts.
Exam II	=	100 pts.
Exam III	=	100 pts.
Final	=	100 pts.

Week 1
Lecture 1 Introduction to Anatomy and Physiology
Lecture 2 Chemical Concepts
No lab

Week 2
Lecture 3 Functions of the Cellular Membrane
Lecture 4 Epithelial Tissue
Lab 1 Introduction to Anatomy and Physiology

Week 3
Lecture 5 Introduction to Connective Tissues
Lecture 6 Connective Tissues: Cartilage, Bones, and Membranes
Lab 2 Active Transport and Diffusion

Week 4
Review
Exam I
Lab 3 Histology

Week 5
Lecture 7 Integumentary System: Epidermis and Dermis
Lecture 8 Integumentary System: Accessory Structures and Tissue Repair
Lab 4 Integument

Week 6
Lecture 9 Purpose and Structure of the Skeleton
Lecture 10 Skeletal System: Bone Development and Growth
Lab 5 Skeletal Overview and Terminology

Week 7
Lecture 11 The Skeleton
Review
Lab 6 Axial and Appendicular Skeletons

Week 8
Exam II
Lecture 12 Articulations
Lab 7 Articulations

Week 9
Lecture 13 Introduction to the Muscular System
Lecture 14 Muscular System: Muscle Contraction
Lab 8 Human Musculature

Week 10
Lecture 15 Muscular System: Cardiac and Smooth Muscle
Lecture 16 Biomechanics of the Muscular System
Lab 9 Muscles and Exercise

Week 11
Review
Exam III
Lab 10 The Human Brain

Week 12
Lecture 17 Introduction to the Nervous System
Lecture 18 Neural Function
Lab 11 Sensory Reception

Week 13
Lecture 19 Spinal Cord and Brain
Lecture 20 Autonomic Nervous System
Lab Review

Week 14
Lecture 21 Sensory System
Lecture 22 Sensory System
Lab Final

Week 15
Review
Review

Week 16
Final Exam

Lecture 1
Introduction to Anatomy and Physiology

I. Characteristics of Living Things

All living things exhibit each of the following characteristics.

A. Living organisms react must be able to react and respond to their environment. This is known as adaptability. For example, an oak tree loses its leaves in the fall in order to prepare for winter.

B. Living organisms must grow and develop throughout a lifetime. Growth involves increasing the number of cells and increasing mass as an organism develops. Differentiation occurs when cells become more specialized as an organism develops.

C. Living organisms must be able to reproduce their species.

D. Living things are able to create movement, whether internally or externally.

E. Living organisms must be able to provide energy in order to carry out the mechanisms needed for survival, and be able to eliminate waste.

II. What is Anatomy?

Anatomy is the study of the external and internal physical structures of a living organism and how these structures interact with one another. The Greek origin of the word anatomy means "to cut apart."

III. Subdivisions of Anatomy

A. Gross anatomy focuses on the study of large organs, such as the heart, kidneys, or brain.

1. Regional anatomy is the study of the structures found in one area of the body (i.e. the arm, head, leg).

2. Systemic anatomy is the study of the body by organ system, like the respiratory or reproductive system.

3. Developmental anatomy focuses on the way the body changes structurally from birth to old age.

B. Microscopic anatomy is the study of body structures that can only be seen by the aid of a microscope.

1. Cytology is the study of the cell.

2. Histology is the study of the tissues of the body.

C. Pathological anatomy looks at how body structures change as a result of disease.

D. Radiographic anatomy studies body structures by X-ray photographs.

IV. What is Physiology?

Physiology is the study of the functions and interactions of the components of a living organism. Physiological study can be very specialized.

V. Subdivisions of Physiology

A. Cell physiology involves the functions and processes that take place at the cellular and molecular level.

B. Specialized physiology focuses on the functions of specific organs of the body.

C. Systemic physiology looks at the function of the individual body systems.

D. Pathological physiology deals with the function of the body as it is affected by disease.

VI. Levels of Organization

A. At the molecular level, atoms combine to form molecules.

B. At the cellular level, molecules act together to form organelles, which in turn, form cells.

C. At the tissue level, groups of cells combine to form a specific function.

D. At the organ level, tissues that are bound together with connective tissue provide a specific function for the body.

E. At the system level, a group of organs works to provide a specific function.

VII. Homeostasis and Regulation

A. Homeostasis means "unchanging" and "standing," and simply means that the internal processes and substances in our body remain stable. As conditions change internally, the body undergoes homeostatic regulation to adapt to these changes. This homeostatic regulation is crucial to life. Homeostatic regulation is possible because of three components: the receptor, a control center, and an effector. The receptor receives a stimulus that an imbalance has occurred. The control center (integration center) takes the message from the receptor and processes it, so that the body can take action. The effector then responds to the message and opposes the imbalance, so that homeostasis is maintained. We maintain homeostasis by two methods, autoregulation and extrinsic regulation

A. Autoregulation is the change within the immediate cell or tissue that needs to adapt to the new environment.

B. Extrinsic regulation occurs when the nervous system or endocrine system controls the various systems of the body.

VIII. Negative and Positive Feedback

Negative feedback occurs when the body opposes a stimulus that causes an imbalance in the body. Negative feedback, the most commonly used form of regulation, maintains conditions for a long-standing period of time. Positive feedback occurs when the body enhances or increases a stimulus that results in an imbalance. The less common, positive feedback is used in instances when the body wishes to speed up a process that should be completed quickly.

IX. Purpose for an Anatomical Frame of Reference

Physicians and researchers must have a common frame of reference when discussing the human body. The body has been divided into numerous landmarks, regions, quadrants, sections, and cavities that allow for specific descriptions of anatomical structure. Many terms have been derived from the Latin or Greek roots and will be used in descriptions throughout the course. Most descriptions and illustrations use the anatomical position as a standard reference point. Anatomical position shows the body standing with arms to the side and palms faced forward.

A. Supine - a body lying face up in anatomical position

B. Prone - a body lying face down in anatomical position

X. Anatomical Landmarks

Anatomical landmarks refer to specific parts of the human anatomy (i.e. carpal or wrist, nasal or nose). Many of these terms will become adjectives in later lectures (i.e. femoral artery).

XI. Regions and Quadrants

There are several regions and four main quadrants of the anatomy that are used when describing the general area or an injury. When using the quadrants (i.e. Right Lower Quadrant, RLQ), the directions are always in reference to the right and left sides of the person being described, not the one observing.

XII. Sections and Planes

When the human body is cut by a variety of planes, several sections are made. Cutting along a specific plane allows a cross section of the anatomy to be seen.

XIII. Body Cavities

Vital organs are enclosed by body cavities. These cavities have two main purposes. First, cavities protect organs such as the brain, spinal cord, and heart are from the normal shocks and jolts that occur to the human body on a daily basis. Second, the cavities allow for changes in organs that are natural processes of the organ function. There are main body cavities, the dorsal body cavity and the ventral body cavity. The dorsal body cavity surrounds and protects the brain and spinal cord with bone and fluid. The cranial cavity houses the brain, and the spinal cavity houses the spinal cord. The ventral body cavity, also known as the coelem, encloses all of the organs on the cardiovascular, respiratory, digestive, reproductive, and urinary systems. The diaphragm separates the ventral body cavity into two smaller cavities, he thoracic cavity and the abdominopelvic cavity.

A. Thoracic Cavity

1. The pericardial cavity contains the heart and acts similar to a fist pushing into a balloon.

2. Pleural cavities lie on each side of the pericardial cavity. Each pleural cavity houses a lung.

3. The mediastinum made of connective tissue and lies between the two pleural cavities.

B. Abdominopelvic Cavity

1. The abdominal cavity (the upper portion of the abdominopelvic cavity) contains the liver, stomach, spleen, small intestine, and much of the large intestine.

2. The pelvic cavity (the lower portion of the abdominopelvic cavity) contains the remaining large intestine, the urinary system, and the reproductive systems of males and females.

Lecture 2
Chemical Concepts

I. Chemical Bonding

Because all matter whether organic or inorganic involves concepts in chemistry, one lecture will be spent discussing chemical concepts. In order for compounds to form, there must be bonds between elements. There are several different types of chemical bonds.

A. Inert elements (noble gases) do not readily bond with other elements. The outer electron shells of these elements are full and therefore create stable elements.

B. Ionic bonds occur between metals and non-metals when atoms lose or gain electrons, which gives them an electrical charge (ion). The attraction between a cation (+ charge) and an anion (- charge) is called and ionic bond. Table salt is the result of an ionic bond between sodium and chlorine.

C. Covalent bonds are strong bonds that occur when atoms fill their outer electron shell by sharing pairs of electrons.

D. Hydrogen bonds are weak chemical bonds involving hydrogen atoms, that are important for shaping molecules and for creating attraction between molecules. While hydrogen bonds are too weak to create molecules, it is these bonds that are responsible for creating surface tension on water and for shaping DNA.

II. Chemical Reactions

A. Oxidation occurs when a molecule is broken down into smaller particles. Catabolism is a decomposition reaction that releases energy in cells when molecules within the cell are broken down. Hydrolysis, which is the breakdown of complex molecules by water, is vital to the decomposition of molecules in the human body.

B. Reduction is a reaction that is opposite a decomposition reaction. Here particles are joined together to create a larger molecule. Anabolism is a reaction that creates a new molecule within a cell. Because anabolism is opposite catabolism, the energy released during catabolism is used up in anabolism.

C. An exchange reaction occurs when the molecules in a reaction are switched. If energy is released in an exchange reaction, it is said to be exergonic. If energy is required, it is considered endergonic. ATP is the energy molecule exchanged in these reactions.

D. Theoretically, chemical reactions are reversible. When the reactions going in both directions achieve a balance, a point of equilibrium is reached. The rate of reaction going either direction depends on the concentration of the reactants and the products.

E. Enzymes can be added to a chemical reaction to speed up the reaction rate. Enzymes are not used up during the reaction, and they do not affect the product of the reaction.

III. Inorganic Compounds

Inorganic compounds are substances in the body that do not contain carbon and hydrogen. These compounds are crucial to your body for carrying out cellular processes.

A. Water is the most important inorganic molecule in the human body. Most inorganic and organic compounds work in conjunction with water. When these inorganic and organic compounds dissolve in water, it creates an aqueous solution. Water is also important in decomposition reactions, where large molecules are broken down in water. Water has a high heat capacity, which means that it is able to absorb and retain heat. Water requires a good deal of heat in order to change temperature and it helps to cool the body because a good deal of heat is removed when water evaporates from the surface of the skin in the form of sweat.

B. The body also contains several inorganic acids and bases. An acid dissociates in water and releases hydrogen ions, which lowers the pH. A base receives hydrogen atoms that are free in a solution. This lowers the pH of the solution. Strong acids and bases dissociate completely in water, whereas weak acids and bases do not completely dissociate. HCl (hydrochloric acid) is a strong acid that is found in the stomach. When HCl combines with water, ions of hydrogen and chloride are formed.

C. Salts are compounds that are formed from an ionic bond between a cation and an anion. In water, the ions separate releasing individual ions. NaCl (table salt) is a common salt found in the human body.

D. Buffers regulate the pH in bodily fluids. The buffer acts to remove or add hydrogen ions to the solution. In order to do this, the related acid or base is added to the solution to balance the pH. Antacids neutralize the HCl in the stomach using a buffer system.

IV. Carbohydrates

All living organisms contain organic compounds. The main elements in organic compounds are carbon and hydrogen, and usually oxygen. Sugars and starches make up carbohydrate compounds. These molecules contain carbon, hydrogen, and oxygen in a ration of 1:2:1. Carbohydrates make up a good deal of the American diet. We will discuss monosaccharides, disaccharides, and polysaccharides.

A. Monosaccharides, or simple sugars, are made of three to seven carbon atoms. Glucose, an important energy releasing molecule, is a monosaccharide.

Isomers have the same molecular formula but have different three-dimensional shapes. Monosaccharides can be different isomers, which is important because the body treats the various isomers as different molecules. Fructose, which is found in fruit, is an isomer of glucose.

B. Joining two monosaccharides form disaccharides. Disaccharides, such as sucrose or lactose, have a sweet taste and are found in many junk foods. The bonds of disaccharides must be broken down by hydrolysis in order to be useful for providing energy.

C. Starches are complex carbohydrates called polysaccharides. Polysaccharides are created when chains of monosaccharides or disaccharides are formed. Plants usually make starches. Cellulose, found in celery, is an example of a starch. Chains of glucose make up glycogen. Glycogen is stored in the liver until there is a need for energy. The liver then breaks down the glycogen and then rebuilds the glycogen stores once the energy need is no longer there.

V. Lipids

Oils, waxes, and fats make up a group of organic compounds called lipids. Fatty acids are a group of lipids that are made up of long carbon chains with a carboxylic acid group. Only the carboyxl end associates with water in solution, so fatty acids are not very soluble in water. Steriods are another group of lipids that are important to humans. Cholesterol is a steriod that help build membranes.

VI. Proteins

Proteins are essential organic compounds that are made up of amino acid chains. Proteins are the most abundant of the organic compounds in the body and they provide several functions. Proteins are responsible for building the support system for cells, tissues, and organs. Proteins also build muscles and the protective covering found in the skin, nails, and hair. There are also transport proteins, buffers, enzymes, and protein hormones that are necessary for proper functioning of the body.

VII. Nucleic Acids

Nucleic acids are organic compounds that form DNA and RNA the information-carrying molecules of the body. Nitrogeneous bases, attached to a sugar and a phosphate group, make up these large molecules. These nitrogeneous bases are guanine, cytosine, adenine, thymine, and uracil.

Lecture 3
Membrane Transport

I. Cell Membrane Structure

The cell membrane is essential in the proper functioning of cells. The cell membrane is a physical barrier that separates the cytoplasm within the cell from the extracellular fluid. It also regulates the movement of materials into and out of the cell. Receptor molecules in the cell membrane can trigger activities within the cell. The cell membrane also provides support for the cell by attaching to other cell membranes or the extracellular matrix. The cell membrane is a phospholipid bilayer made up of lipids, proteins, and carbohydrates.

A. Lipids make up the majority of the cell membrane. Two layers of lipids form the membrane with the hydrophobic tails toward the middle and the hydrophilic heads toward the outside. The lipid bilayer provides and an excellent boundary for the cell.

B. Proteins account for the majority of the weight in the cell membrane. There are integral proteins that lie within the membrane, and there are peripheral proteins that lie on the inner or outer surface of the membrane. There are a variety of proteins associated with the cell membrane, including anchor proteins, recognition proteins, enzymes, receptor proteins, carrier proteins, and protein channels.

C. Carbohydrates in the cell membrane include proteoglycans, glycoproteins, and glycolipids. These compounds lubricate the cell membrane and help to anchor it in place. They also can function as receptor sites. Abnormal glycoproteins and glycolipids can trigger the immune system to react.

II. Membrane Permeability

The permeability of the cell membrane controls the materials going into and out of the cell. In an impermeable membrane nothing can cross the membrane. A freely permeable membrane allows most materials to cross the membrane. In cells, the membrane is considered selectively permeable. In a selectively permeable membrane, certain material may pass freely and other materials may not pass. There are four main ways that materials cross a selectively permeable membrane. These are diffusion, filtration, carrier-mediated transport, and vesicular transport.

A. Diffusion is a passive form of transport, meaning it does not require energy. In diffusion, materials that pass freely across the membrane will pass according to the concentration gradient. The goal of diffusion is to reach equilibrium. Carbon dioxide that is generated by the cells will pass freely into the bloodstream because there is a higher concentration of carbon dioxide inside the cell than in the bloodstream.

B. In filtration, the pressure within a fluid will cause solutes to cross the cell membrane. Filtration occurs in the glomerulus of the kidney.

C. Carrier-mediated permease transport involves a specialized integral protein in the membrane. This form of transport can be passive or active. The sodium-potassium pump is an example of active carrier-mediated transport.

D. Vesicular transport requires energy and involves the transport of materials in vesicles. Substances, such as cholesterol, are carried into the cell by vesicular transport because they are too large to pass through membrane pores.

III. The Transmembrane Potential

The creation of a transmembrane potential is essential to the proper functioning of cells. This potential is created because there is an imbalance of ions on either side of the cell membrane. As certain ions are pumped into the cell and other ions are pumped out of the cell using energy, a potential difference is created. The average membrane potential for a neuron is –70mV.

Lecture 4
Epithelial Tissue

I. General Characteristics of Epithelial Tissue

Epithelial tissue covers body surfaces and lines passageways and internal organs of the body. All epithelial tissues share similar general traits. The cells of epithelial tissue are joined tightly together with cell junctions. The epithelial tissue layer also has one side that always faces the outer surface, called the apical side. The inner side is called the basal surface and connects the epithelium with the inner tissue. This trait is referred to as polarity. The basal surface it attached to underlying tissues by the basement membrane. Epithelial tissue does not contain blood vessels, so it is referred to as avascular. All nutrients are provided by diffusion or absorption across the surface of the tissue. Epithelial cells at the apical surface are continually being regenerated by cells deeper within the tissue.

II. Functions of Epithelial Tissue

There are several functions of epithelial tissue:

A. Epithelial tissue protects exposed and internal surfaces from abrasion, dehydration, damaging chemicals, and microorganisms.

B. Epithelial tissue regulates the molecules, from ions to hormones, that pass into underlying tissue.

C. Epithelial cell layers contain numerous sensory nerves. This allows for a relay of information to the nervous system from the outside environment.

D. Gland cells within the epithelia produce secretions that provide specific functions for the body.

   1. Exocrine glands release secretions on to the skin, such as sweat from exocrine glands and milk from the mammary glands.

   2. Endocrine glands release hormones into interstitial fluid and blood. These hormones are released from several glands, such as the pituitary and thyroid glands.

III. Specialization of Epithelial Cells

Epithelial cells can be specialized for specific functions: producing secretions, enhancing movements across epithelium, moving fluids through epithelium. Some types of epithelium may have microvilla, cilia, or stereocilia that aid in secretion and absorption. Cilia that line the respiratory tract beat in uniform movement to move mucus out of the lungs toward the throat.

IV. Structure of Epithelium

A. Epithelial cells are strongly attached to one another in order to provide a protective barrier. This adhesion is provided by cell adhesion molecules

(CAMs), tight junctions, demosomes, gap junctions, and intercellular cement.

B. Epithelial tissue on the surface of the skin is repaired and replaced by specialized cells called stem cells. Stem cells from the deepest layer of epithelia divide and move to the surface to replace cells that are continually under attack by environmental factors.

V. Epithelial Layers

A. Simple epithelium has only one layer of epithelial cells covering the basement membrane. Simple epithelium is thin and fragile and lines the ventral body cavities and blood vessels.

B. Stratified epithelium has several layers of cells covering the basement membrane. Stratified epithelium, which is found in the skin, is stronger and can handle more environmental stress.

VI. Shapes of Epithelium

A. Squamous epithelium cells are thin, flat, and irregular shaped like puzzle pieces. Simple squamous tissue, the most delicate of the epithelial tissues, is found in the alveoli of the lungs.

B. Cubiodal epithelial cells look like small cubes and form thicker epithelial layers.

C. Columnar epithelial cells are more slender and taller than the cubiodal cells.

VII. Glandular Epithelium

A. Merocrine glands secrete fluids through secretory vesicles by exocytosis. This is the most common form of secretion. Mucus production is one example.

B. In apocrine glands, cytoplasm, plus the secreted fluid, are released to secretory vesicles. Underarm sweat is an example of aprocrine secretion.

C. In holocrine secretion, the gland cell bursts and is destroyed when the secretion is released. This occurs in the sebaceous glands of the hair follicle.

Lecture 5
Introduction to Connective Tissues

I. General Characteristics of Connective Tissue

Connective tissues of the body include bone, fat, and blood. They are found throughout the body and provide several functions. Some of these functions include: providing support, protecting organs, transporting fluids and nutrients, connecting tissues, storing energy, and defending the body from microorganisms.

II. Connective Tissue Proper

Connective tissue is made up of many different types of cells, which perform many varied functions within the body. These cells travel through healthy tissue and then concentrate in sites of injury.

A. Types of Cells

1. Fibroblasts are the most numerous cells and are found in every connective tissue proper. They produce hyaluronan and proteins that give the extracellular fluid a viscous property.

2. Macrophages are amoeba-like cells that are less numerous than fibroblasts. They provide a defense against pathogens and activate the immune system.

3. Adipocytes are fat cells that store energy.

4. Mesenchymal cells are stem cells that divide when an injury occurs to form the various connective tissue cells.

5. Melanocytes contain melanin, which is responsible for the brown pigment in skin.

6. Mast cells release histamine and heparin in the event of injury or infection.

7. Lymphocytes are responsible for the production of antibodies whenever injury or infection occurs.

8. Microphages are phagocytic blood cells that react in the event of infection or injury.

B. Connective Tissue Fibers

1. Collagen fibers are the most common connective fiber and are very strong when bound together.

2. Reticular fibers are similar to collagen fibers but are smaller and are arranged differently than collagen fibers. Reticular fibers can withstand

stresses from a variety of directions.

3. Elastic fibers are more rare than the other fibers. They stretch easily and are found between the vertebrae.

C. Ground substance fills the space between tissues and is fairly dense, which slows the movement of pathogens through the body.

D. Embryonic connective tissue, or mesenchyme, forms all other forms of connective tissue. It is not found in adults.

III. Loose Connective Tissue

Loose connective tissue is the least complex of the connective tissues and it functions to provide cushioning and support between internal organs, blood vessels, and nerves. It separates skin from the underlying tissue and prevents tissue damage when the surface skin in stressed. There are two main types of loose connective tissue, adipose tissue and reticular tissue.

A. Adipose tissue, or fat tissue, provides cushioning, insulation, and energy storage for the body. Brown fat, found mainly in young children is full of blood vessels unlike regular adipose tissue. Blood vessels in brown fat increase lipid breakdown and metabolic heat generation. Very little brown fat is found in adults.

B. Reticular tissue is found in internal organs, such as the liver and spleen, to provide support.

IV. Dense Connective Tissue

Dense connective tissue is a strong connective tissue in which the main fiber is collagen. There are two main types of dense connective tissue.

A. Dense regular tissue contains collagen fibers that are bound together in parallel. Tendons and ligaments are formed by dense regular tissue.

B. Dense irregular tissue is formed by an interwoven mesh of collagen fibers, which holds up well when stress is applied from all directions. Dense irregular tissue covers cartilage, bones, and some internal organs.

V. Fluid Connective Tissue

A. Blood is a fluid connective tissue that contains several types of blood cells that have specific functions. Blood carries oxygen and nutrients to all cells.

B. Lymph is an interstitial fluid that responds to injury or infection.

Lecture 6
Connective Tissues: Cartilage, Bones, and Membranes

I. Cartilage as a Supportive Connective Tissue

Cartilage and bone provide a framework of support for the body and are therefore known as supporting connective tissue. Cartilage is a strong connective tissue, which can be found lining joints and forming the flexible tissue of the nose and ears. In the cartilage matrix, chondrocytes, or cartilage cells, are the only cells that can be found. Cartilage does not contain blood vessels because it produces a chemical that prevents vessel formation. This chemical is currently being studied as a possible cancer treatment because the lack of blood flow would prevent an increase in tumor size.

II. Types of Cartilage

A. Hyaline cartilage is tough but also flexible. This form of cartilage is the most common type of cartilage and is made mainly of collagen fibers. Hyaline cartilage lines synovial joints, the ribs, the sternum, and a portion of the nasal septum.

B. Elastic cartilage is more flexible than hyaline because it contains more elastic fibers. Elastic cartilage forms the pinna of the ear and the tip of the nose.

C. Fibrocartilage is the strongest of the cartilage types and is made almost entirely of collagen fibers. Fibrocartilage forms the intervertebral discs of the spinal column and lines various joints such as the knee.

III. Cartilage Growth

A. Interstitial growth of cartilage occurs as chondrocytes reproduce within the matrix, increasing the amount of cartilage from within. This form of growth is most important during embryonic development.

B. Appositional growth of cartilage occurs as layers of cartilage are added to the surface of the cartilage. Here the inner layer of cartilage creates new matrix, which then adds cartilage to the surface. Appositional growth begins early in development and continues throughout development. While neither interstitial nor appositional growth occurs in adulthood, appositional growth may occur if damage to cartilage occurs.

IV. Osseous Tissue

Osseous tissue, or bone, forms the skeletal systems of the body. Bone, which is less flexible than cartilage, is made up of collagen and calcium salts. The covering of bone is called the periosteum. Bones are connected to other tissues and bones by ligaments and tendons.

V. Membranes

Membranes cover and protect tissues and organs in the body. Epithelial and connective tissues combine to form these membranes.

A. Mucous membranes line the cavities of the respiratory, digestive, reproductive, and urinary systems. These membranes remain moist and perform secretory or absorptive functions.

B. Serous membranes are thin, transparent membranes that line the organs of the ventral body cavity. These membranes reduce friction between the internal organs and allow diffusion of fluids.

C. The cutaneous membrane makes up the skin covering of the body. The cutaneous membrane is thick and relatively dry and protects the body from environmental stresses.

D. Synovial membranes line joints that allow movement. The synovial membrane is made up of collagen fibers and loose connective tissue.

VI. Importance of Connective Tissue

Connective tissues provide an important framework for the body. Connective tissue provides support, keeps internal organs in place, and provides a location for blood vessels, lymph, and nerves.

A. Superficial fascia, or subcutaneous layer, is made up of loose connective tissue and fat. It provides insulation and padding for the underlying tissues.

B. Deep fascia consists of the tissues that form the internal cavities and tie structural tissue together.

C. Subserous fascia forms between deep fascia and serous membranes.

Lecture 7
Integumentary System: Epidermis and Dermis

I. General Characteristics of the Integumentary System

The integumentary system includes the skin, hair, and nails. The epidermis and dermis are components of the skin. Hair and nails form the accessory structures of the integument. The integument is responsible for protecting the body from environmental stresses, and it also provides sensory input to the nervous system.

II. Layers of the Epidermis

The epidermis is the outer skin covering of the body, which protects the internal components of the body. The epidermis includes the thick skin of our palms and soles, which has five cell layers. The thin skin, composed of four cell layers, covers the other areas of our body.

A. The stratum germinativum is the innermost layer of the epidermis. It is attached to the basement membrane, which is connected to the dermis. The stratum germinativum is responsible for the ridges that form our fingerprints.

B. The stratum spinosum contains 8-10 layers of skin cells and is the layer above the stratum germinativum. The stratum spinosum forms as stem cells in the underlying layer divide. This layer contains Langerhans cells, which are part of the immune system.

C. The stratum granulosum contains the keratinocytes which produce the keratohyalin and keratin that form hair and nails. In this layer, the epidermal cells begin to harden and become less permeable.

D. The stratum lucidum is found only in the thick skin of the palms and soles. This is a densely packed, glassy layer of cells filled with keratin.

E. The stratum corneum is the outer layer of the epidermis. In this layer, the cells are densely packed by demosomes, and the cells are relatively dry, which helps to prevent the growth of microorganisms. This layer is water-resistant, but not waterproof, as approximately one pint of water a day is lost through this layer by insensible perspiration.

III. Skin Color

A. The color of skin is determined by two of pigments, carotene and melanin. Carotene is found in certain vegetables like carrots, and it can accumulate in skin cells giving it an orange-yellow color. Melanocytes, found in the stratum germinativum, create the various brown pigments in skin. Melanosomes contain the melanin, and differing sizes of melanosomes account for the differences in racial skin colors. As skin is damaged by the sun's radiation, melanocytes produce more melanin to prevent further skin damage, making skin more tan.

B. The circulation of the blood also affects the color of skin. As oxygen binds to hemoglobin in the blood, blood turns to a red color giving the skin a pink tint. If for some reason circulation increases or decreases, skin color changes. In the cases where skin turns blue, a sustained decrease in circulation causes the hemoglobin to drop the oxygen turning the blood to a deep red color, making the skin above appear blue.

IV. Significance of Vitamin D in the Epidermis

Even though overexposure to sun can do damage to the DNA in epidermal tissue, sunlight is important to skin. In the stratum spinosum, UV radiation changes a cholesterol-like steriod in the epidermis to vitamin D (cholecalciferol). Cholecalciferol is then transformed by the liver, which produces a substance that the kidney uses to produce the hormone calcitriol. Calcitriol is used to maintain the bones.

V. The Dermis

The dermis is the skin layer that lies underneath the epidermis. The dermis contains two layers, the papillary layer and the reticular layer. Loose connective tissue makes up the papillary layer, which contains the sensory neurons and capillaries that supply the surface of the skin. Lines of cleavage occur as collagen and elastic fibers are bundled together. Surgeons cut along these lines of cleavage during surgery. Nerves innervate the dermis, as well as the epidermis. There are sensory nerves for pain and temperature in the epidermis. The dermis contains sensory neurons for light touch, deep pressure, and vibration, in addition to pain and temperature receptors.

Lecture 8
Integumentary Sytem: Accessory Structures and Tissue Repair

I. The Subcutaneous Layer

The subcutaneous layer provides a boundary between the dermis and the underlying tissue. It is made up of loose connective tissue, which includes fat cells. This fat is especially abundant in babies, which gives the extra shock absorption and insulation. The fat within the subcutaneous layer is redistributed in adult men and women. This layer also provides a convenient place to administer injections.

II. Hair

Accessory structures of the integumentary system include the hair, nails, and various glands. Each accessory structure provides a specific function for the body, and is produced as a result of small organs in the integumentary system.

A. Hair grows all over the human body, totaling almost 5 million hairs. Hair is produced in a complex organ called the hair follicle, which involves both the dermis and epidermis. The hair follicle begins in the dermis and extends with the hair projecting out of the epidermis. In the formation of hair, a medulla and hard cortex form. Then, a cuticle, which is a coating of dead keratin cells, forms near the surface of the skin.

B. Hair provides several functions for the body. It protects and insulates the skull. It prevents foreign particles from entering openings such as the nasal passageway and ear canal. Hair that covers the rest of the body adds extra sensory response to the skin. Although not effective in humans, the arrector pili make hairs stand on end (goose bumps), giving extra insulation in colder temperatures.

C. Hair growth occurs as nutrients from the body are absorbed by the hair follicle and added to the hair. When the hair growth cycle ends, the follicle is no longer active, and the hair stops growing. The follicle then begins production of a new hair, which pushes the old hair out.

III. Nails

Nails on the fingers and toes grow as dead cells of keratin grow out from the nail root in each appendage. Nails provide extra protection to fingers and toes. Blood vessels close to the surface of the nail give nails their pink color. The lunula (moons) at the base of the nail appears because the underlying blood vessels cannot be seen. Because of the changes that take place in the body when disease occurs, nails can even be used in diagnosis of various disorders.

IV. Integumentary Glands

A. Sebaceous glands are the glands that produce oil in the skin. Sebum, the oily secretion, is pushed into the hair follicle and on to the surface of the skin by the arrector pili muscle. The sebum moisturizes the keratin in hair and skin, and also helps prevent the growth of bacteria. When the follicles of the sebaceous glands are blocked, it provides an excellent environment for the growth of bacteria, causing boils or acne.

B. Apocrine and merocrine glands produce sweat. Apocrine glands produce the odorous sweat found in the armpits, groin, and nipples. The muscles in the apocrine glands contract because of changes in the nervous system and hormones. Merocrine glands are found in other areas of the skin, mainly the palms and soles. Merocrine glands produce sensible perspiration, which cools the skin, excretes water and electrolytes, dilutes harmful chemicals that get on the skin, and discourages the growth of microorganisms.

C. Mammary glands that secrete milk are also considered integumentary glands. Mammary glands are controlled by pituitary and sex hormones.

D. Ceruminous glands in the ear canal produce ear wax, which help to prevent foreign particles from entering the ear.

V. Injury and Tissue Repair

Injury to the integumentary system is a common occurrence, and fortunately, the epidermis and dermis have adequate stem cells for a quick recovery. In an injury where bleeding occurs, the injury generally protrudes into the dermis. When bleeding occurs a scab forms and macrophages clean the area of debris and microorganisms. In the dermal layer, mesenchymal cells replace the damaged cells. In the epidermal layer, stem cells in the germinative layer replace lost cells. The replacement tissue is actually scar tissue, which is made mostly of collagen and does not have many blood vessels within it.

Lecture 9
Purpose and Structure of the Skeleton

I. Purposes of the Skeletal System

A. The skeletal system provides support for the body and a framework for connecting the various tissues and organs of the body.

B. The bones also provide a reserve of minerals and lipids that are needed for normal body functions.

C. The marrow within bones produces blood cells.

D. The skeleton also protects vital internal organs. For example, the lungs are protected by the rib cage.

E. The skeleton works in conjunction with the muscles to allow movement of the body.

II. General Characteristics of Bones

A. There are various shapes of bones.

1. Long bones, like the femur, are long and slender.
2. Short bones, like the carpal bones, are short and rectangular.
3. Flat bones include the ribs, scapula, and sternum.
4. Irregular bones are found in the spinal column and skull.
5. Sesamoid bones are shaped like a sesame seed. The patella is an example.
6. Sutural bones are found between the irregular bones of the skull.

B. Within bones there is a spongy material that contains the marrow cavity, which contains either yellow marrow or red marrow. Yellow marrow contains many fat cells and functions as an energy reserve. Red marrow produces red blood cells for the blood.

III. Bone Structure

Osseous tissue, or bone tissue, is a dense connective tissue that contains a variety of different cells within its matrix. Calcium phosphate makes up the majority (two-thirds) of the mass of bones. Hydroxyapatite crystals form when calcium phosphate and calcium hydroxide mix. Collagen fibers make up approximately one-third of the mass of bones, and various other bone cells make up approximately two percent of the mass.

IV. Cells within Osseous Tissue

A. Osteoprogenitor cells are the stem cells that create the cells needed to repair breaks or fractures within bones.

B. Osteoblasts are produced by the osteoprogenitor cells and carry out osteogenesis, the formation of new bone matrix. Osteoblasts also control the amounts of organic and inorganic compounds within the bone matrix.

C. Osteocytes, mature bone cells, are found within lacunae, pockets within the bone. Osteocytes, which no longer divide, are the most numerous bone cell. Osteocytes dissolve and release minerals, such as calcium, within the bone. These cells also are transformed to other bone cells like osteoblasts or osteoprogenitor cells in order to help repair tissue in the case of bone injury.

D. Osteoclasts are large cells that dissolve various minerals from the bone matrix in a process called osteolysis. As the osteoclasts remove minerals such calcium from bone, the osteoblasts then replace those minerals back into the bone tissue. The balance between the two is important. If more calcium is removed than is added, then the bones become weak and brittle. In the opposite case, bones become stronger and gain mass.

V. Compact and Spongy Bone

A. Compact bone is found at the surface of bone. It is hard and provides a strong support and protection for the interior of the bone. Osteons, or Haversian systems, make up compact bone. In osteons, osteocytes form concentric circles around a central canal, which contains blood vessels. Compact bone is very strong when forces are applied at the ends of the canals, and less strong when forces are applied perpendicular to the canals. This allows bones to effectively carry the weight of our bodies without breaking.

B. Spongy, or cancellous bone, makes up the interior of bone. Spongy bone contains the same cells as compact bone; however, the cells have a different arrangement. Spongy bone is lighter and less dense than compact bone, which reduces the weight of the skeleton and makes movement easier. While spongy bone is not as strong as compact bone, it is found in areas of bones that are under less stress. Spongy bone is important in that it provides a framework for the bone marrow found within the spongy bone.

C. The periosteum and endosteum are also involved in the maintenance of bone tissue. The periosteum covers compact bone. It functions as a boundary between the bone and surrounding tissues, a pathway for blood vessels and nerves to the bones, and a component in bone growth and repair. The endosteum, a lining in the marrow cavity, also aids in bone growth and repair.

Lecture 10
Skeletal System: Bone Development and Growth

I. Skeletal Formation

Approximately six weeks after fertilization, a skeleton of cartilage begins to develop in a human embryo. Early in development humans transform the cartilage into bone, and bone growth may continue until the age of 25. Ossification is the process where tissues such as cartilage are replaced with bone. Calcification means that calcium salts are being deposited in certain tissues, which may be bone tissue or other tissue types.

A. Intramembranous ossification occurs when osteoblasts form from mesenchymal or fibrous connective tissue. The clavicle and mandible bones are formed from intramembranous ossification. This type of ossification also helps in the repair of damaged bone tissue.

B. Endochondral ossification forms most of our bones. In this process, the embryonic skeleton of cartilage is changed into bone tissue.

C. In bone development, cartilage continues to grow at the epiphyses. Osteoblasts follow behind this cartilage growth to replace this cartilage with bone tissue. In adolescence, bone growth overcomes the epiphyses and cartilage growth. This process elongates our bones.

D. Bones increase in diameter by appositional bone growth. Osteocytes are deposited at the bone's surface, while at the same time osteoclasts remove bone tissue in the center of the bone to increase the marrow cavity.

II. Blood Supply to Bones

Bones are filled with three types of blood vessels that each provide a specific function for the bone. There is one nutrient artery and one nutrient vein in each bone, with the exception of added vessels in larger bones like the femur. Metaphyseal vessels carry blood to areas where bone is replacing cartilage. Periosteal vessels bring blood to the osteons at the surface of bones.

III. Nerve Supply to Bones

Bones contain many lymphatic vessels and sensory nerves. Because of the amount of sensory nerves innervating bones, fractures and breaks to bones are very painful.

IV. Bone Remodeling and Exercise

Organic and inorganic materials within bones are constantly being removed and replaced by the cells in bone tissue. As osteoclasts remove minerals, osteoblasts are replacing them. In a young adult, up to one-fifth of the skeleton can be remodeled through this process. While the main structure of the bone does not change during remodeling, changes in shape or mineral content can change. Because bones can be remodeled, exercise adds stress to bones causing cells to activate increased bone growth. Therefore, those bones continually exposed to the stress of exercise will increase in strength and mass. In the same way, as stress is removed from the skeleton, bones will go through a degenerative process reducing the strength and mass of bones.

V. Hormones and Nutrition

There are a number of hormones and minerals that must be present in order for bone growth and development to occur. Because calcium salts make up a great deal of bones, calcium along with other minerals such as magnesium, fluoride, iron, and manganese must be present. Vitamins C, A, K, and B_{12} are also needed for bone development. The body also produces hormones that stimulate bone growth. Growth hormone, from the pituitary gland, and thyroxine, from the thyroid, activate bone growth. The sex hormones that are prevalent during adolescence also activate bone growth. Calcitriol, from the kidney, calcitonin, from the thyroid, and parathyroid hormone, from the parathyroid also control levels of calcium and phosphate in the body, which is involved in bone development.

VI. Bone Fractures and Breaks

Although bone is strong, cracks (fractures) or breaks may occur. Various breaks or fractures can occur in bones. Simple (closed) fractures occur internally, whereas compound (open) fractures break through the skin adding a danger of infection. When damage occurs, the blood vessels that are broken form a clot called a fracture hematoma at the injury site. Internal and external calluses of cartilage form, which is then replaced by spongy bone tissue. Over the next few months, osteoclasts and osteoblasts remodel the area leaving compact bone. The remaining bone is as strong as it previously was.

VII. The Effects of Aging on the Skeleton

As humans age, a reduction in the skeleton occurs. Osteopenia is the lack of ossification in bones. This occurs because osteoclast activity remains constant while osteoblast activity decreases. Women lose approximately 8 percent of their skeleton a decade, while men generally only lose approximately 3 percent. When the skeleton loses enough mass to impair functioning, it is called osteoporosis. Sex hormones play a large role in bone maintenance, and as women enter menopause the lack of sex hormones further depletes the skeleton.

Lecture 11
The Skeleton

I. Definition of Axial Skeleton

Of the 206 bones in the human body, 80 belong to the skull, vertebral column, and the rib cage. This group of bones is called the axial skeleton. The axial system protects vital organs such as the brain and lungs, and it provides areas for attachment of the muscles needed for upper body movement.

II. The Cranial Cavity and Cranial Bones

A. The purpose of the skull is to protect the brain and the entrances of the digestive and respiratory systems.

B. There are 22 bones that are associated with the cranial cavity: 8 belong to the skull or cranium, 14 belong to the face, 6 bones lie in the auditory canals, and one hyoid bone lies between the temporal lobes.

C. Sutures are immovable joints between the bones of the skull. Sutures are made of dense fibrous connective tissue. Each suture has a name: the lambdoidal, coronal, sagittal, and squamosal are names of four of the sutures.

III. Sinuses

Some facial cranial bones contain air pockets, or sinuses. These sinuses lighten the weight of the bones, and the mucus within the sinus helps to clean the air that enters them. When the sinuses within the nasal complex become inflamed swelling occurs and there is an increase in mucus production, which is known as sinusitis. If the nasal septum has a bend in it, chronic sinus problem may occur as a result of this deviated septum. While the orbital complex that contains the eyeball is not a sinus, it is a similar cavity made up of 7 bones.

IV. Skulls in Infants and Children

Infants are born before the skull has completed ossification. Instead, connective tissue joins the bones at places called fontanels. This makes the skull somewhat flexible and allows for some distortion of the skull during birth. At birth there are four fontanels, three of which close within the first two month of life. The frontal fontanel will remain in children until the age of 2. These fontanels allow for growth of the brain in the first years of life. Abnormalities in fontanel closure can result in skull distortion or brain damage.

V. Vertebrae

The vertebral column of the adult is made up of 24 vertebrae, the sacrum, and the coccyx.

A. The seven cervical vertebrae make up the neck and proceed down to the torso. These vertebrae are the smallest because they only have the weight of the head to support. However, the spinal cord is largest at the cervical vertebrae because it still contains all of the axons within the spinal cord. The spinal cord decreases in size as it goes down the vertebral column. Cervical vertebra C1 is also known as the atlas, from Greek mythology, because is holds up the head. In the first few years of life the atlas fuses to the axis, the second cervical vertebra.

B. The twelve thoracic vertebrae form the upper back and line up with the ribs. Thoracic vertebrae are larger than the cervical vertebrae because they support more weight.

C. The five lumbar vertebrae make up the lower back. These vertebrae are the largest and support the most weight.

D. The sacrum is the fifth lumbar vertebrae. It begins as five vertebrae that fuse together between the ages of 25-30. The sacrum protects reproductive, urinary, and digestive organs, and it provides a good place for the attachment of the leg muscles.

E. The coccyx begins as three to five vertebrae that go through ossification and fusion in late adulthood. The coccyx also provides a place for muscle and ligament attachment.

VI. Spinal Curvature

The adult spinal column contains four curves. Two of these curves are present at birth, and the other two develop by the age of 10. These curves allow for proper support of body weight. Abnormalities in spinal curvature can occur, such as in the disorders of lordosis, kyphosis, and scoliosis.

VII. Anatomy of Vertebrae

A. The body, or centrum, of the vertebrae carries the weight. Ligaments connect vertebral bodies, but intervertebral discs lie in the space between each vertebra.

B. The vertebral arch along with the vertebral foramen encases the spinal cord.

C. The articular processes help to align the vertebrae.

VIII. The Thoracic Cage

The thoracic cage includes the ribs, sternum, and thoracic vertebrae. This group of bones is responsible for protecting the respiratory organs and the heart, and it provides an attachment site for muscles needed in breathing.

A. Twelve pairs of ribs begin on the thoracic vertebrae and curve around to form the walls of the thoracic cavity. The first seven pairs of ribs are known as true ribs because they attach directly to the sternum via the costal cartilages. The next five pairs of ribs are not directly attached to the sternum and are called false ribs. The last two pairs of ribs are called floating ribs because they attach only at the vertebrae. Ribs are somewhat flexible and can handle certain stresses without breaking. However, severe enough blows may crack ribs, which will usually heal without a cast or splint.

B. The sternum is a flat bone that the ribs connect to. The sternum is actually made up of four separate bones that fuse together in adulthood.

IX. Definition of the Appendicular Skeleton

The appendicular skeleton is made up of the bones of the pectoral (shoulder) girdle including the arm and hand bones, along with the pelvic girdle including corresponding leg and foot bones.

X. The Pectoral Girdle

The clavicles and the scapulae lie within the pectoral girdle. These are important bones for the attachment of muscles that control arm movements. The clavicles are fairly small and weak bones that can break easily.

XI. Bones of the Arm

A. The humerus is the bone of the upper arm, or brachium. The radial nerve runs along the humerous, which transmits sensory information from the back of the hand and controls the muscles that straighten the elbow.

B. The ulna and the radius are the parallel bones in the forearm. These two bones form a joint at the elbow, which allows rotation of the forearm.

C. Eight small bones (carpals) form the wrist.

XII. Bones of the Hand

Five bones called metacarpals, which are attached to the carpals, form the bones of the hand. The phalanges, the bones of the finger, extend from the metacarpals. The thumb, or pollex, contains two phalanges, while the other fingers contain three phalanges.

XII. The Pelvic Girdle

Because they support the weight and movement of the upper body, the bones of the pelvic girdle are stronger and larger than those bones in the pectoral girdle. The pelvic girdle consists of two coxae bones called the sacrum and the coccyx, which are fused together. There are differences in the pelvises of men and women. The pelvis in women is lighter and gives more room for child-bearing.

XIII. Bones of the Lower Limbs

A. The femur is the longest and strongest bone in the body. It extends from the pelvic girdle to the patella.

B. The patella, or kneecap, is a sesamoid bone that lies within the tendon of the quadriceps femoris and is connected to the tibia by ligaments.

C. The tibia is the large bone of the lower leg.

D. The fibula is the smaller bone of the lower leg. The fibula does not join the femur, but does provide a place for muscle attachment.

E. Seven tarsal bones make up the ankle. These bones articulate with both the tibia and fibula.

F. The foot has five long metatarsals, which form the soles of the feet. These metatarsals articulate with phalanges to form the toes. The phalanges in the foot are similar to the hand in that the big toe, or hallux, contains two bones, while the other toes contain three bones.

Lecture 12
Articulations

I. Types of Articulations

Bones come together at junctions called joints, or articulations. Articulations allow movement, and the type of joint determines the type of movement that can occur.

A. Immovable joints do not move and are often interlocking. In the skull, sutures that are made of dense connective tissue are found between immovable joints. Gompheses bind teeth to their bony sockets to prevent movement. A synchondrosis is a cartilage connection between immovable bones, as is found in the pelvic girdle. Synostoses are bony fusions in which the individual bones can no longer be identified, such as in the frontal bone of the skull.

B. Slightly movable joints allow slight movement. They are stronger, but less flexible than freely movable joints. The bones involved are usually joined by cartilage or collagen fibers. Examples of slightly movable joints include the bones of the pelvis, the joining of the tibia and fibula, and the intervertebral discs.

C. Freely movable joints, which allow a larger range of motion, are also called synovial joints. Synovial joints have a lining of articular cartilage and synovial fluid. In normal synovial joints, the bones actually never touch because of the cushioning of the cartilage and fluid. Rheumatism and arthritis are disorders in which the articular cartilage in the joint deteriorates and the padding within the joints is reduced, increasing friction and causing pain.

II. Components within Synovial Joints

A. Synovial fluid, which is full of proteoglycans, has the texture of molasses and has important functions within the synovial joint. The fluid lubricates the joint by forming a liquid cushion between the lining of articular cartilage. It also transports nutrients and waste into and out of the joint. Finally, synovial fluid helps to cushion the joint under the pressure of activities such as walking or running.

B. Menisci and fat pads provide added cushioning within the synovial joint. A meniscus is a fibrocartilage pad, and fat pads are made of adipose tissue.

C. Ligaments also help to strengthen synovial joints by adding support to the joint wall. In a sprain, some collagen fibers within the ligament may be torn, but overall, ligaments are very strong and not likely to tear.

D. Tendons are not directly part of synovial joints, but they may pass next to joints and provide added support or limit movement in certain directions.

E. Bursae are small pockets filled with synovial fluid. While they are often associated with synovial joints, they usually occur where ligaments or tendons rub against other tissues. Bursae reduce friction and provide added cushioning under pressure.

III. Types of Joints

A. Gliding joints are flat, slightly curved joints that slide past one another. Movement in gliding joints is small, and ligaments prevent rotational movement. These joints are found in the clavicles, tarsals, carpals, and vertebrae.

B. Hinge joints allow movement in one plane, similar to movement in a door hinge. Examples of hinge joints include the elbow, knee, and ankle.

C. Pivot joints allow rotation only. The joint between the axis and the atlas allow you to turn your head. Another pivot joint allows rotation of the hand.

D. Ellipsoidal joints involve a bone or group of bones with a curved face that rest in the depression of an adjoining bone. This joint which gives a wide range of motion is found where the carpals articulate with the radius, and where the metacarpals and metatarsals meet the phalanges of the fingers and toes.

E. Saddle joints form when bones with concave faces rest on each other. This joint does not allow rotation. The thumb is an example of a saddle joint.

F. Ball-and-socket joints, which provide a wide range of rotational and angular motion, are formed when the ball-shaped end of one bone fits within the cup-like depression of another bone. The shoulder and hip joints are examples of ball-and-socket joints.

IV. Specific Articulations

A. Intervertebral articulations include the gliding joints between articular processes of adjacent vertebrae and the symphyseal joints between vertebral bodies. Movement within the vertebral column includes bending forward (flexion), bending backward (extension), bending to the side (lateral flexion), and rotation.

   1. Intervertebral discs are cartilage pads filled with water. The discs act as shock absorbers for the vertebrae and account for approximately one-fourth the length of the vertebral column. During aging, the water within the disc decreases, shortening the length of the vertebral column.

   2. Intervertebral ligaments connect and provide stability to the vertebrae.

B. The ball-and-socket joint of the shoulder gives the most movement of any joint in the body. However, because of the wide range of motion, a sacrifice is made in the strength and stability of the joint. The shoulder joint also suffers the most dislocations, especially for those athletes that put great strain on the shoulder. Many ligaments and muscles from the pectoral girdle and humerus provide stability to the shoulder joint.

C. The elbow, a hinge joint, is very stable because the humerus and ulna interlock. The ulnar nerve runs across the back side of the elbow, and this nerve may make the front side of the arm feel numb when it is hit. Therefore, it is known as the funny bone.

D. The hip joint in contrast to the shoulder joint is a strong and stable ball-and-socket joint. Padding within is this joint includes fibrocartilage and fat pads. The strong articular capsule with the supporting ligaments and muscles reinforce the joint, making dislocations rare.

E. The knee joint is a complex joint and while officially a hinge joint it is actually like three joints in one. Seven ligaments work to stabililize the knee joint.

Lecture 13
Introduction to the Muscular System

I. Functions of Skeletal Muscle

Muscles work with the skeletal system and other tissues to allow humans to move and carry out the activities necessary for everyday life. There are three basic types of muscle tissue: skeletal, cardiac, and smooth. Skeletal muscle connects to bones to provide movements like running, sitting, standing, etc. Cardiac muscle forms the heart that pumps blood throughout the body. Smooth muscle is found in internal organs and controls the digestive system and other various organs.

A. Skeletal muscle works with the skeleton to produce body movements.

B. Contraction of skeletal muscle keeps our body posture when sitting or standing.

C. Skeletal muscle protects internal organs and tissues.

D. Skeletal muscle controls the entrances and exits of the digestive and urinary tracts.

E. During muscle contraction heat is released, helping to maintain our body temperature.

II. Anatomy of Skeletal Muscle

Connective tissues, blood vessels, nerves, and muscle tissue are all found within skeletal muscles. Each component provides a specific function for the muscle.

A. Three layers of connective tissue play a vital role in the muscle. The epimysium is a dense outer layer of collagen that surrounds the whole muscle. The perimysium separates the muscle into fasicles, or bundles of muscle fibers. The endomysium covers each muscle fiber and ties it to the other fibers. All three layers of connective tissue combine together at the ends of the muscles to form tendons, which join skeletal muscles to bones.

B. Because skeletal muscles require so much energy to function, they need numerous blood vessels and nerves to supply the needed stimulation and nutrients. Blood provides the necessary nutrients and oxygen, and nerves stimulate muscle contraction.

III. Anatomy of Muscle Tissue

A. The sarcolemma is the membrane that surrounds muscle fibers, and a change in the electrical potential of the sarcolemma induces contraction.

B. The transverse tubules lie at right angles to the sarcolemma and infiltrate the muscle tissue. Electrical signals from the sarcolemma travel along the transverse tubules to induce muscle contraction.

C. Myofibrils lie within the muscle fiber and are responsible for the contraction of the muscle. Myofibrils extend the entire length of the muscle fiber and contain myofiliments, which are made up of thin and thick filiments.

D. The sarcoplasmic reticulum surrounds each of the transverse tubules.

E. The myofilaments within the myofibril form sarcomeres, the functional unit of contraction. Overlapping layers of thick and thin filaments form dark bands (A bands) and light bands (I bands) within the sarcomere.

F. The thin filaments contain three proteins: F actin, tropomyosin, and troponin. Combinations of tropomyosin and troponin are responsible for the contraction.

G. The thick filaments are made of twisted strands of myosin that form a head and tail and cross-bridges that interact with the thin filaments.

Lecture 14
Muscular System: Muscle Contraction

I. The Sliding Filament Theory

The sliding filament theory explains how muscle contraction occurs, as thick and thin filaments move past one another, and the overlap between the two increases. The H bands and I bands get smaller, but the A bands remain constant. Therefore, the shortening of the sarcomere causes muscle contraction.

II. Process of Muscular Contraction

Muscle contraction begins as a neuron sends an electrical signal to the neuromuscular junction. The neuron releases acetylcholine (ACh) into the synaptic cleft, which lies between the synaptic terminal of the neuron and the sarcolemmal surface. Receptor sites on the sarcolemmal surface receive the ACh, which leads to depolarization of the membrane and the propagation of the action potential. The action potential travels along the transverse tubules, which trigger the release of calcium ions from the sarcoplasmic reticulum. The calcium ions bind to troponin, which causes the removal of the tropomyosin from the actin binding sites on the thin filament. This allows for the creation of myosin cross bridges. The repeated action of the cross bridges increases the overlap of thick and thin filaments, creating muscle contraction.

III. The Role of Troponin, Tropomyosin, and Myosin

As ACh triggers calcium ions to enter the sarcoplasm, these ions bind to troponin molecules. This binding weakens the bond between troponin and tropomyosin and causes the myosin head to bind to the active sites on the actin. In the resting sarcomere these myosin heads point away from the M line. After forming cross-bridges, these myosin heads pivot, causing muscle contraction as the thin and thick filament slide past one another. When the myosin head is detached, it is then recocked ready to again contract the muscle.

IV. Effects of Repeated Stimulation

The all-or-none principle states that an individual muscle fiber is either turned ON or turned OFF. The strength of tension within one muscle fiber is dependent on the number of cross-bridges, but as more muscle fibers are repeatedly stimulated the strength of the contraction increases. Incomplete tetanus occurs when rapid cycles of stimulation and relaxation occur, finally reaching a peak tension. Complete tetanus occurs when rapid stimulation eliminates the relaxation stage as peak tension is reached. Most muscle contractions involve complete tetanus. Treppe happens when the muscle is repeatedly stimulated after the relaxation phase has ended. The contraction becomes stronger with each stimulation.

V. Motor Units and Muscle Tone

Muscle tone is sustained in muscles as motor units provide background stimuli when the muscle is at rest. With increased exercise of muscles, the number of motor units that provide the background stimuli increases making muscle appear "toned," even at rest.

VI. Types of Contractions

A. Isotonic contractions involve the shortening of the muscle as an object places resistance on the muscle, and the object is moved.

1. In concentric contraction the tension within the muscle causes the muscle to shorten. For example, when lifting a box off the table the bicep muscles shorten.

2. In eccentric contraction the opposite occurs. The tension within the muscle does not overcome the resistance and the muscle elongates. For example, when laying a box on a table, tension within the biceps allows you to lay the box down gently, but the muscle itself elongates.

B. In isometric contractions the muscle itself does not shorten because the resistance is not overcome by the contraction. Pushing on a wall is an example of isometric contraction. The individual muscle fibers will shorten until the tendons are pulled tight.

VII. Energetics of Muscles

A. Because large amounts of ATP are required to run muscles, the body stores up ATP in the form of creatine. During contraction ATP is broken down into ADP. Creatine then converts this ADP back into ATP.

B. The tricarboxylic acid (TCA) cycle forms ATP molecules in the presence of oxygen. With every molecule that enters this aerobic process there is a net production of 38 ATP molecules.

C. Glycolysis is a less efficient anaerobic process that produces only 2 ATP molecules and 2 pyruvic acid molecules with the breakdown of one glucose molecule. However, glycolysis is important when the oxygen needed is not available.

VIII. Cori Cycle

The Cori cycle is important for transforming the lactic acid produced during glycolysis back to pyruvic acid. The liver converts the lactic acid back to pyruvic acid, which can then be used by the mitochondria to create ATP, or it can be used to restore glycogen reserves.

IX. Muscle Strength

A. Types of muscle fibers

1. Fast fibers contract in 0.01 second or less, are large in diameter, and are sustained by glycolysis. Therefore, they tire easily.

2. Slow fibers are smaller is diameter and take about three times longer to stimulate than fast fibers. Slow fibers contain more capillaries and myoglobin, which increase oxygen flow to the muscle. This makes the muscle tissue appear red, whereas fast fibers appear white.

B. Hypertrophy occurs as muscle tissue is repeatedly stimulated, and the myofibrils increase in number. The number of muscle fibers does not increase, but the diameter of the fibers increases making the muscles appear larger.

C. Atrophy occurs when muscle suffers a lack of stimulation. The result is a reduction of size, tone, and power.

X. Aging and the Muscular System

The natural process of aging causes a loss in the size and strength of muscle tissue. The muscle fibers decrease in diameter, and fibrosis decreases the flexibility. Aging also reduces the ability for exercise, and the muscles are less able to recover after injury.

Lecture 15
Muscular System: Cardiac and Smooth Muscle

I. Structure of Cardiac Muscle Tissue

As the name implies, cardiac muscle is found only in the heart. Cardiocytes are cardiac muscle cells that are small and contain a centrally located nucleus. Cardiac muscle is striated because it contains myofibrils and sarcomeres as does skeletal muscle.

II. Intercalated Discs

The intercalated discs are found between cardiac muscle cells where the cells are joined together by gap junctions and desmosomes. These allow a quick and regulated electrical stimulation of the heart muscle.

III. Function of Cardiac Muscle

A. Because the cardiac muscles cells are so closely joined to one another contraction exists as if the heart were one large muscle cell. This is known as a functional syncytium.

B. The pacemaker cells regulate the timing of the contractions of the heart. Cardiac cells act without neural stimulation, which is known as automaticity.

C. The nervous system can affect the speed of contractions of the heart. But, the heart muscle does not undergo wave summation, because doing so would cause cardiac arrest.

IV. Structure of Smooth Muscle

Smooth muscle is non-striated and is found in most organs of the body. The nucleus of smooth muscle is found in the center and there are no T-tubules, myofibrils, or sarcomeres located in the cell. Instead, dense bodies hold smooth muscles cells together.

V. Locations of Smooth Muscle

A. In the integumentary system, smooth muscle lines blood vessels and controls the arrector pili.

B. In the cardiovascular system, smooth muscle lines blood vessels and helps control blood pressure.

C. In the respiratory system, smooth muscle lines passageways and controls airflow.

D. In the digestive system, smooth muscle moves materials along each component of the digestive tract.

E. In the urinary system, smooth muscle controls filtration in kidney and moves urine to the bladder, and pushes urine out of the body.

F. In the reproductive system, smooth muscle moves sperm in males and oocytes in females along the reproductive tract. It also is responsible for expelling the fetus out of the uterus at delivery.

VI. Function of Smooth Muscle

Gap junctions join the non-striated cells of smooth muscle. The gap junctions allow for a unified contraction within the muscle tissue. There appears to be pacemaker cells that when stimulated, initiate contractions in the surrounding smooth muscle. Smooth muscle tissue take longer to contract (50-100 msec after excitation) and remain contracted (1-3 sec) longer than skeletal tissue. There are both similarities and differences between smooth muscle tissue and skeletal muscle tissue.

A. Similarities in smooth and skeletal muscle include the following characteristics.

1. ATP is the molecule used for energy.

2. Calcium ions released in the intracellular matrix trigger contraction.

3. Contraction results from the sliding of thick and thin filaments.

B. Differences in smooth and skeletal muscle include the following characteristics.

1. There are fewer thick filaments in relation to thin filaments in smooth muscle tissue.

2. There do not appear to be troponin on the thin filaments of smooth muscle.

3. There are no visible T tubules, and the sarcoplasmic reticulum is poorly developed.

4. Smooth muscles are not striated.

5. Smooth muscles have diffuse junctions instead of the highly structured neuromuscular junctions found in skeletal muscles.

Lecture 16
Biomechanics of the Muscular System

I. Arrangement of Muscle Fibers

Muscle fibers are arranged in parallel bundles called fascicles. Fascicles are then arranged in one of four ways, in order for the muscle to function in a specific way.

A. In most skeletal muscles, the fascicles are aligned parallel to each other. As the muscle contracts, the muscle shortens and bulges in the center, which is called the belly, or gaster.

B. In muscles such as the pectoral muscles, the fascicles fan out over a broad area but have one attachment point, such as a tendon. These convergent muscles do not pull as hard on the attachment points as parallel muscles do.

C. Pennate muscles resemble a feather. There are more muscle fibers within pennate muscles than in parallel muscles, which produces more muscle tension. However, there is less pull on tendons.

D. Sphincters are circular muscles where the fascicles are arranged in a circle around entrances and exits of the digestive and urinary tracts. As the muscle contracts, the size of the opening decreases.

II. Levers

Muscles do not work alone, but instead work in conjunction with bones, joints, and other muscles to provide a wider range of movement and to generate more force. Bones act as levers to increase the strength of muscles, and joints act as fulcra, which are pivot points of the lever.

A. Muscles that extend the neck are an example of a first-class lever, which resembles a seesaw. The fulcrum in a first-class lever lies between the resistance and the applied force.

B. The muscles and bones of the foot show a second-class lever, where the fulcrum lies at one end, the resistance in the center, and the applied force at the opposite end of the fulcrum.

C. The arm represents a third-class lever. Here the elbow is the fulcrum at one end of the lever, the resistance is applied at the opposite end, and the force is applied in the center.

III. Origins, Insertions, and Actions

A. The origin is the point that a muscle begins, which usually remains stationary during contraction.

B. The insertion point is where the muscle ends, which usually involves movement.

C. Action is the movement of the skeleton involved. An action is described by the bone or joint that is moved. A prime mover is a muscle that is mainly responsible for a specific movement, such as the bicep. An antagonist is a muscle that works against a specific movement, such as the tricep, which oppose the movement of the bicep. A muscle that acts as a synergist aids the prime mover in specific action.

Lecture 17
Introduction to the Nervous System

I. Divisions of the Nervous System

A. The central nervous system (CNS) is comprised of the brain and spinal cord. The CNS controls sensory response and motor control. The brain is also responsible for intelligence, thinking, and memory.

B. The peripheral nervous system (PNS) is made up of all the neural tissue outside the central nervous system. The nerves of the PNS carry the signals sent to and from the CNS.

C. The somatic nervous system (SNS) contains the nerves that control skeletal muscles, which can be voluntary or involuntary.

D. The autonomic nervous system (ANS) controls the smooth muscles of the internal organs, the cardiac muscle, and the glands. It also contains two subdivisions, the sympathetic and parasympathetic nervous systems.

II. Structure of the Neuron

Neurons are the cells of the nervous system that are responsible for carrying all of the information, either sensory or motor control.

A. The soma is the cell body of the neuron, which contains the nucleus.

B. The dendrites are branch-like projections from the soma that receive information from nearby neurons.

C. The axon is a long extension from the soma that propagates the action potential from neuron to neuron. The synaptic terminal at the end of the axon is the release site of neurotransmitters into the synaptic cleft.

D. The synapse is the space between the synaptic terminal one axon and the dendrites of the adjacent neuron. Communication between two neurons takes place in the synapse by way of chemicals called neurotransmitters.

III. Variations in Neuron Structure

A. Anaxonic neurons appear to only have dendrites.

B. Bipolar neurons have dendrites that extend from the soma on one side, and an axon with synaptic knobs on the other end.

C. Unipolar neurons are similar to bipolar neurons except that the soma lies off to one side.

D. Multipolar neurons have the soma at one end with the dendrites extending directly from the cell body, and the axon extending from the cell body in the opposite direction.

IV. Variations in Neuron Function

A. Sensory neurons deliver information received by the sensory receptors to the CNS. Sensory neurons are generally unipolar and relay information from either the external or internal environment. Exteroreceptors deliver information from the outside environment, proprioreceptors relay information about muscles and joints, and interoceptors pick up information from the internal organs, including the sensations of taste, deep pressure, and pain.

B. Motor neurons deliver information from the CNS to the tissues of the periphery, such as skeletal muscles and organ systems.

C. Interneurons are found only in the CNS, and they are responsible for coordinating motor control and organizing sensory information.

V. Neuroglia

Neuroglia are cells within the nervous system that provide functions other than the relaying of information.

A. Astrocytes in the CNS maintain the blood-brain barrier, provide support, control neurotransmitter concentrations, and repair damaged tissue.

B. Oligodendrocytes in the CNS myelinate axons and provide support.

C. Microglia in the CNS are phagocytes that remove debris, waste, and pathogens.

D. Ependymal cells line the brain and spinal cord and regulate the cerebrospinal cord.

E. Satellite cells in the PNS cover the somata in ganglia.

F. Schwann cells myelinate the axons of the PNS.

VI. Myelination

Neuroglial cells form myelin sheaths around the axons of many neurons, which increases the speed of the action potentials propagating through the neurons. Certain diseases like multiple sclerosis cause the disintegration of myelin, which leads to numbness and paralysis.

Lecture 18
Neuron Function

I. The Transmembrane Potential

The fluid within cells differs from the fluid outside cells because of differing amounts of ions. This causes a concentration and electrical gradient across cell membranes. Without this potential cells would not function.

A. A concentration gradient occurs in cells, including neurons, because there are more sodium and chloride ions in the extracellular fluid than in the intracellular fluid. The cytosol, or intracellular fluid, contains higher concentrations of potassium ions and negatively charged proteins. Therefore, because of diffusion, these differing ion concentrations are continually trying to reach equilibrium.

B. An electrical gradient exists across cell membranes because the potassium (+) ion can more easily diffuse through the membrane than can sodium (+) ions. This leaves the negatively charged proteins within the cell and creates a potential difference across the membrane. In general, the potential difference across the neuron membrane is -70mV, which is known as the resting potential.

II. Ion Channels

Ions move across the membrane via ion channels.

A. Passive channels remain open to the diffusion of ions.

B. Chemically regulated channels only open in response to the binding of a specific molecule.

C. Voltage regulated channels open when the membrane potential reaches a specific voltage.

D. Mechanically regulated channels open when the membrane undergoes a specific physical change, which occurs in sensory receptors.

III. Action Potentials

Action potentials are responsible for the function of neurons. Action potentials begin as the transmembrane potential in a neuron goes from -70mV to between -60mV to -55mV, which is the threshold potential. When the threshold value is reached, the voltage-regulated channels open allowing sodium ions into the cell. Action potentials follow an all-or-none principle, which means that an action potential is either generated or is not generated by a specific stimulus.

IV. Na-K Pump

The sodium-potassium pump plays an important role in the generation of the action potential. The Na-K pump maintains the cell's resting potential. The pump uses ATP and pushes three sodium ions outside the cell and brings two potassium ions into the cell.

V. Action Potential Propagation

Continuous propagation occurs in unmyelinated axons. The action potential begins at the initial segment of the axon and gradually moves down the axon, depolarizing each segment of membrane as it goes. The action potential moves down the entire axon and to the next neuron. This form of propagation travels at approximately 1 m/s.

A. Saltatory propagation occurs in myelinated axons. Myelinated membranes cannot depolarize at the myelination sites. Therefore, there are nodes along the membrane that can depolarize and can propagate the action potential. Saltatory propagation involves the “jumping” of the action potential down the axon, which is much faster than continuous propagation.

B. The speed of axon potential propagation depends on myelination and axon diameter. Cytoplasm within the axon creates resistance for the axon potential and slows the propagation.

   1. Type A fibers refer the fastest and largest axons. These axons are myelinated and action potentials travel at 140 m/s.

   2. Type B fibers are also myelinated, but they are smaller in diameter. These axons propagate action potentials at 18 m/s.

   3. Type C fibers are unmyelinated and are the smallest in diameter. Action potentials only travel at 1 m/s.

C. The direction that the action potential is propagated depends on where the action potential is initiated. Most action potentials begin at the axon hillock, after the soma has been depolarized by a neurotransmitter. These action potentials travel in only one direction toward the synaptic terminal. Action potentials can also be initiated at nodes along the axon. If an action potential begins at a node, the action potential will travel in both directions. The action potential will have no effect on the soma, but will propagate to the synaptic terminal in the other direction. Once it reaches the synaptic terminal, neurotransmitters will be released to depolarize the next neuron.

VI. Role of the Synapse

A. Electrical synapses are found in only a few areas of the CNS and PNS, including the eye and vestibular nuclei. The two neurons are joined by a gap junction, which transfers an electrical current quickly through the synapse.

B. Chemical synapses use neurotransmitters to create action potentials in adjacent neurons. As an action potential reaches the synaptic knob of the presynaptic neuron, a neurotransmitter is released into the synapse. Depending on the receptors of the postsynaptic neuron, this neurotransmitter may depolarize the cell enough to generate an action potential.

C. Cholinergic synapses involve the transmitter Acetylcholine (ACh), which is released in the synapses of skeletal muscle neurons. ACh is found in many other synapses of the CNS and PNS.

VII. Neurotransmitters

Neurotransmitters are responsible for the propagation of action potentials along chemical synapses. Neurotransmitters can be excitatory, which depolarizes the cell and generates an action potential, or they can be inhibitory, which hyperpolarizes the cell and prevents an action potential.

A. Acetylcholine, which is excitatory, is the most commonly used neurotransmitter.

B. Norepinephrine is an excitatory neurotransmitter found in the brain and ANS.

C. Dopamine can be inhibitory or excitatory and is used in various areas of the brain. Dopamine levels are responsible for Parkinson's disease and cocaine addiction.

D. Serotonin also present in the brain can alter emotional states and influences the presence of migraine headaches.

E. Gamma aminobutyric acid (GABA) is an inhibitory neurotransmitter that seems to reduce anxiety and may be associated with epilepsy.

Lecture 19
Spinal Cord and Brain

I. Anatomy of the Spinal Cord

A. Gray matter is the nerve tissue that lies within the vertebra of the spinal column.

B. White matter is the bone tissue that surrounds the nerves of the spinal cord.

C. Spinal meninges are membranes that surround the spinal cord to protect it from the vertebra and other shocks the spine may encounter.

1. The dura mater is the outer meninges that protects the spinal cord. It is made mainly of collagen fibers and is the site for epidural anesthesia.

2. The arachnoid forms the second layer of the meninges. Cerebrospinal fluid is contained in the arachnoid, which is withdrawn in a spinal tap. Spinal taps are used in order to diagnosis various problems within the nervous system.

3. The pia mater is the innermost meningeal layer and is made of elastic and collagen fibers. The pia mater contains the blood vessels needed by the spinal cord. It is tightly interwoven into the neural tissue, unlike the other meningeal layers.

III. Reflexes

Reflexes are quick reactions to sudden changes in the environment. The route of a reflex is known as a reflex arc. The reflex arc is a process that begins with a stimulus that triggers a receptor and a sensory neuron. This sensory neuron travels to the spinal cord and activates an interneuron. The interneuron then triggers a motor neuron, which gives instructions for the body to react.

A. Innate reflexes, such as withdrawal from pain, chewing or sucking, are formed during development.

B. Acquired reflexes are learned throughout life, such as a batter dodging a wild pitch.

C. Spinal reflexes involve neurons that lie within the spinal cord.

D. Cranial reflexes involve neurons within the brain.

E. Somatic reflexes cause the skeletal muscles to react.

F. Visceral reflexes cause the smooth and cardiac muscles to react.

IV. Development of the Human Brain

As the human embryo develops the brain goes through a series of divisions. At three weeks the prosencephalon, mesencephalon, and rhombencephalon have formed. At six weeks the telencephalon has formed, which has developed into the cerebrum by birth. The diencephalon and mesencephalon that form at six weeks remain the same divisions at birth. The metencephalon at six weeks later forms the cerebellum and pons by birth. The myelencephalon later becomes the medulla oblongata.

V. Organization of the Brain

The human brain is divided into several sections. Each section provides a specific function in controlling processes that go on in the body.

A. The cerebrum is the largest part of the brain and is found in the frontal lobe. The cerebrum controls conscious thought, memory, intellect, complex movement, and sensation. A series of sulci and gyri are found in the cerebrum to increase the surface area.The corpus callosum lies between the left and right hemisphere, and allows communication to take place between the two sides of the brain.

B. The diencephalon lies in the center of the brain controls conscious and unconscious sensory information.

   1. The pineal gland is in the diencephalon. It is the gland that releases melatonin, which is the hormone thought to regulate light/dark cycles.

   2. The thalamus is a relay site for sensory information going to the primary sensory cortex.

   3. The hypothalamus is essential for normal body functioning. It controls unconscious skeletal contractions, like facial expressions. The hypothalamus is the area responsible for certain emotional and behavioral drives, such as thirst and hunger. The hypothalamus also regulates body temperature and controls various hormone secretion.

C. The cerebellum is found in the posterior portion of the brain under the cerebrum. It is responsible for coordination, equilibrium, and balance. This is the area of the brain that allows you to fine tune muscle movement. The cerebellum allows you to improve a specific skill in a sport, for example.

D. The pons is located in the brain stem. It contains the sensory and motor nuclei for four of the cranial nerves. The pons also helps regulate respiration and serves as a relay station for the cerebellum.

E. The medulla oblongata, also located in the brain stem, connects the brain to the spinal cord. The medulla oblongata controls the internal organs and serves as a relay station for the sensory and motor pathways.

Lecture 20
The Autonomic Nervous System

I. Description of the Autonomic Nervous System

As the name implies, the autonomic nervous system acts without conscious thought. It regulates conditions within the internal organs. The autonomic nervous system is divided into two opposing divisions called the sympathetic and parasympathetic nervous systems.

II. Somatic Nervous System v. Autonomic Nervous System

There are many differences between the somatic nervous system that controls the skeletal muscles and the autonomic nervous system.

A. The somatic system controls skeletal muscles and the autonomic system controls cardiac muscle, smooth muscle, and glands.

B. Neurons in the somatic system fire faster than autonomic neurons.

C. Somatic neurons release ACh to stimulate skeletal muscles, which is always excitatory. Autonomic neurons release norepinephrine and ACh, which can be excitatory or inhibitory.

III. The Sympathetic Division

The sympathetic division of the autonomic nervous system prepares the body for a crisis situation. This is often called the “fight or flight” response. Situations in the outside environment trigger the sympathetic response. When activated, neurons stimulate the release of epinephrine and norepinephrine from the adrenal medullae. There are several physical responses that result when the sympathetic division is activated.

A. There is an increase in mental alertness.

B. The metabolic rate increases.

C. Digestive and urinary function decreases.

D. Blood pressure, breathing rate, and heart rate increase.

E. Production from the sweat gland increases.

F. The muscles become more tones and ready for action.

IV. The Parasympathetic Division

The parasympathetic division opposes the actions of the sympathetic division. The parasympathetic division releases ACh at synaptic terminals. ACh receptors in the paraympathetic division can be either nicotinic or muscarinic receptors. When the parasympathetic division activates it, the body responds opposite from the sympathetic division.

A. The body reacts in a “rest and repose” state.

B. The metabolic rate, blood pressure, and heart rate decrease.

C. Action in the digestive system increases.

D. Urination and defecation increases.

E. There is increased sexual arousal.

Lecture 21
Sensory Reception

I. Overview of Sensory Function

The human body uses sensory receptors to learn about and adapt to the external environment. Sensory receptors receive and translate information about the environment for the CNS. This transfer of information is called transduction. General sensory receptors include the senses of pain, temperature, touch, pressure, vibration, and proprioception. There are also more complex sensory organs for the senses of olfaction, vision, gustation, equilibrium, and hearing.

II. General Sensory Receptors

The receptor sites for the general senses are located throughout the body and are fairly simple in structure.

A. Exteroceptors receive information from the outside environment.

B. Proprioceptors relay information about body position.

C. Interoceptors provide information about visceral organs.

D. Nociceptors are pain receptors in the epidermis, joints, bones, and wall of blood vessels. Some nociceptors are sensitive to extreme temperatures. Some are receptive to mechanical damage, and others report on chemicals released by damaged cells.

E. Thermoreceptors are temperature sensitive receptors that are located in the dermis, skeletal muscles, liver, and hypothalamus. Cold receptors are more numerous than warm receptors.

F. Mechanoreceptors receive information when cell membranes are distorted. These include the tactile receptors that sense touch, pressure, and vibration. Baroreceptors sense pressure in the digestive, reproductive, and urinary systems.

G. Chemoreceptors respond to changes in the concentration of chemicals or compounds in the body. For example, chemoreceptors monitor the amount of carbon dioxide and oxygen in the blood.

III. Olfaction

Olfactory organs in the nasal cavity are responsible for the ability to detect various smells. As air enters the nasal cavity, it passes by the olfactory receptors. The pathway then leads to the olfactory organs. Because olfaction does not pass through the thalamus before reaching the cerebral cortex, certain scents tend to bring an emotional and behavioral response. Our olfactory system can also distinguish between 2000-4000 different chemical stimuli.

IV. Gustation

Gustatory, or taste receptors, that are located across the tongue provide information on taste. Taste receptors along with epithelial tissue form taste buds. Olfactory organs also enhance taste reception. The primary taste sensations are sweet, salt, sour, and bitter. Two additional taste sensations have also been discovered. Umami recognizes the presence of amino acids, and is activated by things such as beef or chicken broth. Water receptors have also been located. When water is held in the mouth, it causes additional water loss in the kidneys.

Lecture 22
Sensory Reception

I. Vision

As humans, we rely on our vision more than any other sense. The eyes are very complex organs, and several structures work together to provide humans with accurate eyesight.

II. Accessory Structures of the Eye

Structures that are not directly part of the visual organs aid in the production of visual images.

A. Eyelids lubricate the eyes and remove debris from the surface of the eye.

B. The lacrimal apparatus produces, distributes, and removes tears from the eyes. Tears lubricate the eye, remove debris, prevent bacterial infection, and provide nutrients and oxygen to the conjunctiva.

III. The Eye

The complex eyeball lies within the orbital cavity. Orbital fat pads and insulates the eye. The eye is made of several parts that provide a specific function.

A. The fibrous tunic, the outermost layer, contains the sclera and cornea. This layer gives mechanical support and provide and attachment site for eye muscles. It also assists in focusing.

B. The vascular tunic is the middle layer that contains the iris, the ciliary body, and the choroid.

1. The iris contains the pigment that gives eyes color. The two layers of smooth muscle in the iris controls the size of the pupil.

2. The ciliary body, which lies posterior to the iris, contains smooth muscle and connective tissue that hold the lens in place.

3. The choroid is a vascular layer that transports oxygen and nutrients to the retina.

C. The neural tunic, or retina, is the innermost layer of the eye. The retina contains photoreceptors that respond to light. Rods are photoreceptors that recognize shades of black and white. Cones are photoreceptors that respond to colors.

D. The lens focuses an image on to the photoreceptors on the retina.

IV. Visual disorders

A. Cataracts occur when the lens loses its transparency. Cataracts can be the result of drug reactions, radiation, or injury, but the most common cause is aging.

B. Glaucoma results when pressure within the eye builds up. Pressure builds because the aqueous humor is not able to drain, even though production of the fluid continues.

C. Myopia, or nearsightedness, occurs when the shape of the eyeball is elongated.

D. Hyperopia, or farsightedness, occurs when the shape of the eyeball is too shallow.

V. Equilibrium and Hearing

The ear is the organ that provides the sense of hearing and equilibrium. There are three divisions of the ear: the external ear, the middle ear, and the inner ear.

A. The external ear includes the pinna, which is the outer fleshy flap, and the ear canal. These two structures funnel sound in toward the tympanic membrane. The tympanic membrane is very delicate and separates the external ear from the middle ear. The external ear also includes the ceruminous glands that produce ear wax.

B. The middle ear is filled with air and consists of the eustachian tube. The middle ear also contains the auditory ossicles, which are the three smallest bones in the body. These bones are the malleus, the incus, and the stapes.

C. The inner ear provides the receptor sites for hearing and equilibrium. The semicircular canals contain receptors that are stimulated as the head moves. The semicircular canals are the site for equilibrium reception. The cochlea is a spiral shaped structure that contains the receptors that provide hearing.

Lecture 1
Introduction to Anatomy and Physiology

I. Characteristics of Living Things

II. What is Anatomy?

III. Subdivisions of Anatomy

A. Gross anatomy –

1. Regional anatomy –

2. Systemic anatomy –

3. Developmental anatomy –

B. Microscopic anatomy –

1. Cytology –

2. Histology –

C. Pathological anatomy –

D. Radiographic anatomy –

IV. What is Physiology?

V. Subdivisions of Physiology

A. Cell physiology –

B. Specialized physiology –

C. Systemic physiology –

D. Pathological physiology –

VI. Levels of Organization

A. At the molecular level –

B. At the cellular level –

C. At the tissue level –

D. At the organ level –

E. At the system level –

VII. Homeostasis and Regulation

A. Autoregulation –

B. Extrinsic regulation –

VIII. Negative and Positive Feedback

IX. Purpose for an Anatomical Frame of Reference

A. Supine –

B. Prone –

X. Anatomical Landmarks

XI. Regions and Quadrants

XII. Sections and Planes

XIII. Body Cavities

A. Thoracic Cavity

1. The pericardial cavity –

2. Pleural cavities –

3. The mediastinum –

B. Abdominopelvic Cavity

1. The abdominal cavity –

2. The pelvic cavity –

Lecture 2
Chemical Concepts

I. Chemical bonding

A. Inert elements –

B. Ionic bonds –

C. Covalent bonds –

D. Hydrogen bonds –

II. Chemical Reactions

A. Decomposition –

B. Synthesis –

C. An exchange reaction –

D. Reversible reactions –

E. Enzymes –

III. Inorganic Compounds

A. Water –

B. Acids and bases –

C. Salts –

D. Buffers –

IV. Carbohydrates

A. Monosaccharides –

B. Disaccharides –

C. Starches –

V. Lipids

VI. Proteins

VII. Nucleic Acids

Lecture 3
Membrane Transport

I. Cell Membrane Structure

A. Lipids –

B. Proteins –

C. Carbohydrates –

II. Membrane Permeability

A. Diffusion –

B. Filtration –

C. Carrier-mediated transport –

D. Vesicular transport –

III. The Transmembrane Potential

Lecture 4
Epithelial Tissue

I. General Characteristics of Epithelial Tissue

II. Functions of Epithelial Tissue

A. Protection –

B. Regulation –

C. Sensory information –

D. Gland cells –

1. Exocrine glands –

2. Endocrine glands –

III. Specialization of Epithelial Cells

IV. Structure of Epithelium

V. Epithelial Layers

A. Simple epithelium –

B. Stratified epithelium –

VI. Shapes of Epithelium

A. Squamous epithelium cells –

B. Cubiodal epithelial cells –

C. Columnar epithelial cells –

VII. Glandular Epithelium

A. Merocrine glands –

B. Apocrine glands –

C. Holocrine glands –

Lecture 5
Introduction to Connective Tissues and Membranes

I. General Characteristics of Connective Tissue

II. Connective Tissue Proper

A. Types of Cells

1. Fibroblasts –

2. Macrophages –

3. Adipocytes –

4. Mesenchymal cells –

5. Melanocytes –

6. Mast cells –

7. Lymphocytes –

8. Microphages –

B. Connective Tissue Fibers

1. Collagen fibers –

2. Reticular fibers –

3. Elastic fibers –

C. Ground substance –

D. Embryonic connective tissue –

III. Loose Connective Tissue

A. Adipose tissue –

B. Reticular tissue –

IV. Dense Connective Tissue

A. Dense regular tissue –

B. Dense irregular tissue –

V. Fluid Connective Tissue

A. Blood –

B. Lymph –

Lecture 6
Connective Tissues: Cartilage, Bones, and Membranes

I. Cartilage as a Supportive Connective Tissue

II. Types of Cartilage

A. Hyaline cartilage –

B. Elastic cartilage –

C. Fibrocartilage –

III. Cartilage Growth

A. Interstitial growth –

B. Appositional growth –

IV. Osseous Tissue

V. Membranes

A. Mucous membranes –

B. Serous membranes –

C. Cutaneous membrane –

D. Synovial membranes –

VI. Importance of Connective Tissue

A. Superficial fascia –

B. Deep fascia –

C. Subserous fascia –

Lecture 7
Integumentary System: Epidermis and Dermis

I. General Characteristics of the Integumentary System

II. Layers of the Epidermis

A. The stratum germinativum –

B. The stratum spinosum –

C. The stratum granulosum –

D. The stratum lucidum –

E. The stratum corneum –

III. Skin Color

A. Skin pigmentation –

B. Blood circulation –

IV. Significance of Vitamin D in the Epidermis

V. The Dermis

Lecture 8
Integumentary Sytem: Accessory Structures and Tissue Repair

I. The Subcutaneous Layer

II. Hair

III. Nails

IV. Integumentary Glands

A. Sebaceous glands –

B. Apocrine and merocrine glands –

C. Mammary glands –

D. Ceruminous glands –

V. Injury and Tissue Repair

Lecture 9
Purpose and Structure of the Skeleton

I. Purposes of the Skeletal System

II. General Characteristics of Bones

A. There are various shapes of bones.

1. Long bones –
2. Short bones –
3. Flat bones –
4. Irregular bones –
5. Sesamoid bones –
6. Sutural bones –

B. Bone marrow –

III. Bone Structure

A. Cells within Osseous Tissue

1. Osteoprogenitor cells –

2. Osteoblasts –

3. Osteocytes –

4. Osteoclasts –

B. Compact and Spongy Bone

1. Compact bone –

2. Spongy bone –

3. The periosteum and endosteum –

Lecture 10
Skeletal System: Bone Development and Growth

I. Skeletal Formation

A. Intramembranous ossification –

B. Endochondral ossification –

II. Blood Supply to Bones

III. Nerve Supply to Bones

IV. Bone Remodeling and Exercise

V. Hormones and Nutrition

VI. Bone Fractures and Breaks

VII. The Effects of Aging on the Skeleton

Lecture 11
Skeletal System: The Axial System

I. Definition of Axial Skeleton

II. The Cranial Cavity and Cranial Bones

III. Sinuses

IV. Skulls in Infants and Children

V. Vertebrae

A. Cervical vertebrae –

B. Thoracic vertebrae –

C. Lumbar vertebrae –

D. The sacrum –

E. The coccyx –

VI. Spinal Curvature

VII. Anatomy of Vertebrae

A. The body –

B. The vertebral arch –

C. The articular process –

VIII. The Thoracic Cage

IX. Definition of the Appendicular Skeleton

X. The Pectoral Girdle

XI. Bones of the Arm

XII. Bones of the Hand

XII. The Pelvic Girdle

XIII. Bones of the Lower Limbs

A. Femur –

B. Patella –

C. Tibia –

D. Fibula –

E. Tarsals –

F. Metatarsals –

Lecture 12
Articulations

I. Types of Articulations

A. Immovable joints –

B. Slightly movable joints –

C. Freely movable joints –

II. Components within Synovial Joints

A. Synovial fluid –

B. Menisci and fat pads –

C. Ligaments –

D. Tendons –

E. Bursae –

III. Types of Joints

A. Gliding Joints –

B. Hinge joints –

C. Pivot joints –

D. Ellipsoidal joints –

E. Saddle joints –

F. Ball-and-socket joints –

IV. Specific Articulations

A. Intervertebral articulations –

1. Intervertebral discs –

2. Intervertebral ligaments –

B. The ball-and-socket joint of the shoulder –

C. The elbow –

D. The hip joint –

E. The knee joint –

Lecture 13
Introduction to the Muscular System

I. Functions of Skeletal Muscle

II. Anatomy of Skeletal Muscle

III. Anatomy of Muscle Tissue

A. Sarcolemma –

B. Transverse tubules –

C. Myofibrils –

D. Sarcoplasmic reticulum –

E. Sarcomeres –

F. Thin filaments –

G. Thick filaments –

Lecture 14
Muscular System: Muscle Contraction

I. The Sliding Filament Theory

II. Process of Muscular Contraction

III. The Role of Troponin, Tropomyosin, and Myosin

IV. Effects of Repeated Stimulation

V. Motor Units and Muscle Tone

VI. Types of Contractions

A. Isotonic contractions –

1. Concentric contractions –

2. Eccentric contractions –

B. Isometric contractions –

VII. Energetics of Muscles

A. Creatine –

B. The tricarboxylic acid (TCA) cycle –

C. Glycolysis –

VIII. Cori Cycle

IX. Muscle Strength

A. Types of muscle fibers

1. Fast fibers –

2. Slow fibers –

B. Hypertrophy –

C. Atrophy –

X. Aging and the Muscular System

Lecture 15
Muscular System: Cardiac and Smooth Muscle

I. Structure of Cardiac Muscle Tissue

II. Intercalated Discs

III. Function of Cardiac Muscle

A. Syncytium –

B. Pacemaker cells –

C. Wave Summation –

IV. Structure of Smooth Muscle

V. Locations of Smooth Muscle

A. Integumentary system –

B. Cardiovascular system –

C. Respiratory system –

D. Digestive system –

E. Urinary system –

F. Reproductive system –

VI. Function of Smooth Muscle

A. Similarities in smooth and skeletal muscle include the following characteristics.

1.

2.

3.

B. Differences in smooth and skeletal muscle include the following characteristics.

1.

2.

3.

4.

5.

Lecture 16
Biomechanics of the Muscular System

I. Arrangement of Muscle Fibers

A. Fascicle arrangement –

B. Convergent muscles –

C. Pennate muscles –

D. Sphincters –

II. Levers

A. First-class lever –

B. Second-class lever –

C. Third-class lever –

III. Origins, Insertions, and Actions

A. Origin –

B. Insertion point –

C. Action –

Lecture 17
Introduction to the Nervous System

I. Divisions of the Nervous System

A. The central nervous system (CNS) –

B. The peripheral nervous system (PNS) –

C. The somatic nervous system (SNS) –

D. The autonomic nervous system (ANS) –

II. Structure of the Neuron

A. The soma –

B. The dendrites –

C. The axon –

D. The synapse –

III. Variations in Neuron Structure

A. Anaxonic neurons –

B. Bipolar neurons –

C. Unipolar neurons –

D. Multipolar neurons –

IV. Variations in Neuron Function

A. Sensory neurons –

B. Motor neurons –

C. Interneurons –

V. Neuroglia

A. Astrocytes –

B. Oligodendrocytes –

C. Microglia –

D. Ependymal cells –

E. Satellite cells -

F. Schwann cells –

VI. Myelination

Lecture 18
Neuron Function

I. The Transmembrane Potential

A. Concentration gradient –

B. Electrical gradient –

II. Ion Channels

Ions move across the membrane via ion channels.

A. Passive channels –

B. Chemically regulated channels –

C. Voltage regulated channels –

D. Mechanically regulated channels –

III. Action Potentials

IV. Na-K Pump

V. Action Potential Propagation

A. Continuous propagation –

B. Saltatory propagation –

C. The speed of axon potential propagation depends on myelination and axon diameter. Cytoplasm within the axon creates resistance for the axon potential and slows the propagation.

1. Type A fibers –

2. Type B fibers –

3. Type C fibers –

D. Propagation direction –

VI. Role of the Synapse

A. Electrical synapses –

B. Chemical synapses –

C. Cholinergic synapses –

VII. Neurotransmitters

A. Acetylcholine –

B. Norepinephrine –

C. Dopamine –

D. Serotonin –

E. Gamma aminobutyric acid (GABA) –

Lecture 19
Spinal Cord and Brain

I. Anatomy of the Spinal Cord

A. Gray matter –

B. White matter –

C. Spinal meninges –

1. The dura mater –

2. The arachnoid –

3. The pia mater –

III. Reflexes

A. Innate reflexes –

B. Acquired reflexes –

C. Spinal reflexes –

D. Cranial reflexes –

E. Somatic reflexes –

F. Visceral reflexes –

IV. Development of the Human Brain

V. Organization of the Brain

A. Cerebrum –

B. Diencephalon –

1. The pineal gland –

2. The thalamus –

3. The hypothalamus –

C. Cerebellum –

D. Pons –

E. Medulla Oblongata –

Lecture 20
The Autonomic Nervous System

I. Description of the Autonomic Nervous System

II. Somatic Nervous System v. Autonomic Nervous System

III. The Sympathetic Division

IV. The Parasympathetic Division

Lecture 21
Sensory Reception

I. Overview of Sensory Function

II. General Sensory Receptors

The receptor sites for the general senses are located throughout the body and are fairly simple in structure.

A. Exteroceptors –

B. Proprioceptors –

C. Interoceptors –

D. Nociceptors –

E. Thermoreceptors –

F. Mechanoreceptors –

G. Chemoreceptors

III. Olfaction

IV. Gustation

Lecture 22
Sensory Reception

I. Vision

II. Accessory Structures of the Eye

A. Eyelids –

B. The lacrimal apparatus –

III. The Eye

A. The fibrous tunic –

B. The vascular tunic –

1. The iris –

2. The ciliary body –

3. The choroid –

C. The neural tunic –

D. The lens –

IV. Visual disorders

A. Cataracts –

B. Glaucoma –

C. Myopia –

D. Hyperopia –

V. Equilibrium and Hearing

A. The external ear –

B. The middle ear –

C. The inner ear –

Name ________________________________ Section ______ Date ____________

Anatomy and Physiology I
Exam I

Multiple Choice (2 points each)

_____ 1. The Greek origin of the word anatomy means

A. "pieced together" B. "to cut apart"
C. "part of the whole" D. "look within"

_____ 2. The subdivision of anatomy that looks at the structure of the cell is called

A. regional anatomy B. histology
C. developmental anatomy D. cytology

_____ 3. The study of the functions and interactions of the structures within a living organism is called

A. physiology B. anatomy
C. cytology D. histology

_____ 4. All living organisms exhibit the following

A. responsiveness B. movement
C. growth D. A and B only E. all the above

_____ 5. In an increasing level of organization, groups of cells combine to form

A. molecules B. tissues
C. organs D. systems

_____ 6. The brain, lungs, and kidneys combine to form which level of organization

A. tissue B. organ
C. system D. none of the above

_____ 7. ________________ means that the body has a mechanism to ensure that the pH level in the blood remains stable.

A. Stimulus B. Regulation
C. Homeostasis D. Feedback

Matching (2 points each)

_____	8. Responsiveness	A. Formation of seed in a pine cone
_____	9. Growth and Differentiation	B. Blood flowing through capillaries
_____	10. Reproduction	C. A tree loses its leaves in the fall
_____	11. Movement	D. A group of cell develop into the brain of an embryo
_____	12. Metabolism and Excretion	E. The kidney remove waste from the blood

Multiple Choice (2 points each)

_____ 13. Anatomical position is described as

A. body standing and arms overhead
B. body lying supine with palms faced down
C. body lying with arms overhead
D. body standing with palms faced forward

_____ 14. The body cavity surrounding the brain and spinal cord is called the

A. ventral body cavity
B. dorsal body cavity
C. pelvic cavity
D. pericardial cavity

_____ 15. When referring to the anatomy, you always use the perspective of the

A. patient
B. observer

_____ 16. The growth of cartilage that occurs in embryonic development is called

A. Interstitial cartilage growth
B. appositional cartilage growth

_____ 17. Which of the following is NOT a function of epithelial tissue?

A. protects exposed internal surfaces from dehydration
B. reception site for sensory stimuli
C. transports nutrients and oxygen
D. regulates the passage of materials into underlying tissue

True/False (2 points each)

_____ 18. Some types of epithelial tissue contain cilia.

_____ 19. Squamous epithelial cells form the thickest epithelial layers.

_____ 20. Merocrine glands secrete underarm sweat.

_____ 21. Stratified epithelium is stronger than simple epithelium.

_____ 22. Stem cells are responsible for the creation of new cells.

_____ 23. Exocrine glands secrete hormones.

_____ 24. Negative feedback, the most common form of regulation, opposes the stimulus that causes an imbalance in the body.

Multiple Choice (2 points each)

_____ 25. Which of the following glands secretes oil in the hair follicle?

A. merocrine glands
B. apocrine glands
C. sebaceous glands

_____ 26. Which of the following is NOT a characteristic of the inert elements?

A. called the noble gases
B. do not easily bond with other elements
C. helium is one of them
D. lack one electron in the outer shell

_____ 27. The attraction of a cation and an anion creates a(an)

A. ionic bond B. covalent bond

C. hydrogen bond D. polar covalent bond

_____ 28. Surface tension of water is created by

A. ionic bonds B. covalent bonds

C. hydrogen bonds C. polar covalent bonds

_____ 29. Table salt results from a(an)

A. ionic bond B. covalent bond

C. hydrogen bond D. polar covalent bond

_____ 30. The reaction that breaks down food after it is eaten is called

A. synthesis B. anabolism

C. decomposition D. enzymatic

_____ 31. Enzymes _____________ the reaction.

A. are used up in B. speed up

B. slow down D. are created by

Inorganic Compounds – Matching (2 points each)

_____ 32. Water A. releases hydrogen atoms

_____ 33. Base B. cools as it evaporates from the skin

_____ 34. Acid C. formed from an ionic bond

_____ 35. Salt D. receives hydrogen atoms

_____ 36. Buffers E. regulates the pH in bodily fluids

Organic Compounds – Matching (2 points each)

_____ 37. Carbohydrates A. make up the DNA molecule

_____ 38. Lipids B. made up of amino acid chains

_____ 39. Proteins C. includes sugars and starches

_____ 40. Nucleic acids D. cholesterol

Multiple Choice (2 points each)

_____ 41. Which strong, flexible connective tissue is found in articulations, in the tip of the nose, and in the ears?

A. bone B. blood

C. cartilage D. fat

_____ 42. The connective tissue that stores energy and provides cushioning is

A. adipose tissue B. bone
C. blood D. cartilage

_____ 43. The cell membrane is made of

A. carbohydrates B. lipids
C. proteins D. all the above

_____ 44. Which of the following requires energy?

A. diffusion B. osmosis
C. filtration D. vesicular transport

_____ 45. The transmembrane potential results because there is a difference in ___________________ across the cell membrane.

A. hydrostatic pressure B. voltage
C. water concentration D. protein concentration

Connective Tissues – Matching (2 points each)

_____ 46. Melanocytes A. fat cells

_____ 47. Fibroblasts B. produce antibodies

_____ 48. Mast cells C. contains brown skin pigment

_____ 49. Adipocytes D. release histamine

_____ 50. Lymphocytes E. give viscosity to extracellular fluid

Name ______________________________ Section ______ Date ____________

Anatomy and Physiology I
Exam II

Multiple Choice (2 points each)

_____ 1. Which of the following is NOT part of the integumentary system?

A. Nails B. Cartilage
C. Hair D. Sebaceous glands

_____ 2. The lunula is part of

A. the hair follicle B. the apocrine gland
C. the fingernail D. the dermis

_____ 3. Hair functions

A. to add insulation B. to protect openings from foreign particles
C. to add sensory reception D. A and B only E. all the above

_____ 4. Scar tissue looks different from regular tissue because

A. it's made mainly of collagen B. it contains fewer blood vessels
C. it isn't formed from stem cells D. A and B only E. all the above

True/False (2 points each)

_____ 5. The skin on the palms is thinner than the skin on the face.

_____ 6. Hair and nails are formed from keratin.

_____ 7. Melanosome size is responsible for racial skin color differences.

_____ 8. Sunlight is important for proper bone development.

_____ 9. The dermis is the outermost layer of skin.

_____ 10. Bone fractures are painful because bones contain numerous blood vessels.

_____ 11. Ceruminous glands produce oil in the skin.

Bone Cells – Matching (2 points each)

_____ 12. Osteoprogenitor cells A. mature bone cells

_____ 13. Osteoblasts B. remove minerals from bones

_____ 14. Osteocytes C. stem cells

_____ 15. Osteoclasts D. from new bone matrix

Multiple Choice (2 points each)

_____ 16. What condition might develop if osteoclast activity exceeded osteoblast activity?

A. ossification B. osteopenia
C. osteogenesis D. scoliosis

_____ 17. Which of the following systems are necessary for the maintenance of a healthy skeleton?

A. integumentary system B. circulatory system
C. respiratory system D. A and B only E. all the above

_____ 18. Where are blood cells produced?

A. periosteum B. bone marrow
C. osteons D. blood

_____ 19. How many bones are normally in the human body?

A. 204 B. 203
C. 208 D. 206

_____ 20. An infant's skull is fragile because

A. the fontanels have not closed B. the bone in the skull is not thick enough
C. there isn't any hair for protection D. none of the above

_____ 21. What is the longest and strongest bone in the body?

A. patella B. clavicle
C. scapula D. femur

_____ 22. If you break a finger, you probably have broken which bone?

A. a carpal B. a metacarpal
B. the ulna D. a phalange

Bone Shapes – Matching (2 points each)

_____ 23. Long bone A. patella

_____ 24. Short bone B. femur

_____ 25. Sesamoid bone C. sternum

_____ 26. Flat bone D. vertebrae

_____ 27. Irregular bone E. carpal bone

True/False (2 points each)

_____ 28. Once bones are formed, they never change.

_____ 29. Floating ribs attach at the sternum only.

_____ 30. The skeleton can be divided into the axial and appendicular skeletons.

_____ 31. Hair is produced in the hair follicle.

_____ 32. Mammary glands are controlled by pituitary and sex hormones.

_____ 33. Sex hormones have no effect on the maintenance of bones in women.

Epidermis – Matching (2 points each)

_____	34. Stratum germinativum	A. contains keratinocytes
_____	35. Stratum spinosum	B. attached to the basement membrane
_____	36. Stratum granulosum	C. found only the palms and soles
_____	37. Stratum lucidum	D. relatively dry and water-resistant
_____	38. Stratum corneum	E. contains Langerhans cells

Short Answer (6 points each)

40. Draw a simple sketch of the spinal vertebrae and label the five major sections.

41. Name five functions of the skeletal system.

Name ________________________________ Section ______ Date ____________

Anatomy and Physiology I
Exam III

Joints – Matching (2 points each)

_____ 1. Hinge joint — A. the shoulder

_____ 2. Pivot joint — B. the elbow

_____ 3. Ball-and-socket joint — C. slightly curved joints that slide past one another

_____ 4. Saddle joint — D. allow rotation only

_____ 5. Gliding joint — E. joint between concave faces; the thumb

Multiple Choice (2 points each)

_____ 6. Structurally, the weakest type of articulations are
A. immovable joints B. slightly movable joints
C. bony fusions D. freely movable joints

_____ 7. Which of the following do NOT provide support and cushioning in synovial joints?
A. Gompheses B. Menisci
C. Synovial fluid D. Ligaments

_____ 8. Which of the following disorders result when articular cartilage deteriorates?
A. Arthritis B. Rheumatism
C. Bursitis D. A and B only E. all the above

_____ 9. Which of the following is NOT a characteristic of synovial fluid?
A. has consistency of molasses B. contains proteoglycans
C. lubricates the joint D. made primarily of collagen

_____ 10. Bursae are
A. small pockets of synovial fluid B. concave faces on joints
C. tears in ligament tissue D. pads of adipose tissue

_____ 11. As a person reaches old age the vertebral column
A. lengthens B. shortens
C. fuses together D. curves

True/False (2 points each)

_____ 12. The shoulder joint is stronger than the hip joint.

_____ 13. Cartilage pads absorb shock between the vertebrae.

_____ 14. Skeletal muscles and smooth muscles are striated.

_____ 15. The sarcoplasmic reticulum is the membrane that surrounds muscle fibers.

_____ 16. Neuromuscular fibers operate on the all-or-none principle.

Muscle Structure – Matching (2 points each)

_____ 17.	Sarcolemma	A. carry electric signals to induce contraction
_____ 18.	Sarcoplasmic reticulum	B. membrane surrounding muscle fibers
_____ 19.	Myofibrils	C. contain actin, troponin, tropomyosin
_____ 20.	Transverse tubules	D. surrounds transverse tubules
_____ 21.	Thin filaments	E. contain the thick and thin filaments

Multiple Choice (2 points each)

_____ 22. The idea that thick and thin filaments move past one another to cause contraction is known as

A. the all-or-none principle B. the ACh binding theory
C. the sliding filament theory D. the TCA cycle

_____ 23. The ___________________ produces the most energy to run muscles

A. TCA cycle B. Cori cycle
C. glycolysis D. creatine formation

_____ 24. Pushing on a wall is an example of

A. isotonic contraction B. isometric contraction
C. concentric contraction D. eccentric contraction

_____ 25. Fast fibers are white in color because

A. they contain bone cells B. they contain cartilage
C. they are as fast as lightning D. they do not contain many capillaries

_____ 26. What happens to muscles as a person ages?

A. muscles decrease in size B. muscles become fatty
C. muscle fibers decrease in diameter C. A and C only E. all the above

True/False (2 points each)

_____ 27. Intercalated discs are found in skeletal muscle.

_____ 28. Smooth muscle is found in the lining of internal organs.

_____ 29. A prime mover is the main muscle involved in a specific action.

_____ 30. Atrophy of muscle tissue happens when muscles are exercised regularly.

_____ 31. Acetycholine is the neurotransmitter that stimulates muscle contraction.

_____ 32. Potassium ions are responsible for the binding of thick and thin filaments.

_____ 33. Peak tension is reached during treppe contractions.

Muscles – Matching (2 points each)

_____	34. Sphincter	A. regulate the timing of cardiac muscle contraction
_____	35. Lever	B. circular muscles around body entrances and exits
_____	36. Origin	C. increase the strength of muscles
_____	37. Pacemaker cells	D. contraction of cardiac cells without neural stimulation
_____	38. Automaticity	E. point where a muscle begins

Short Answer

39. Name three functions of skeletal muscle (3 points).

40. Name three differences between skeletal muscles and smooth muscles (3 points).

41. Briefly describe the process of skeletal muscle contraction (6 points).

Name ________________________________ Section ______ Date ____________

Anatomy and Physiology I
Final Exam

Multiple Choice (2 points each)

_____ 1. The nervous system provides the following functions
A. stimulates muscle movement B. allows conscious thought
C. controls body temperature D. A and B only E. all the above

_____ 2. The brain and spinal cord make up the
A. peripheral nervous system B. central nervous system
C. autonomic nervous system D. sympathetic nervous system

_____ 3. The covering on axons that increases the speed of action potentials is called
A. myelination B. microglia
C. reception D. synaptic communication

_____ 4. Which of the following is true about action potentials?
A. occur in all cells B. only occur in the CNS
C. occur only in the ANS D. dependent on the membrane potential

_____ 5. Which of the following are the fastest neurons?
A. Type A fibers B. Type B fibers
C. Type C fibers D. Type D fibers

_____ 6. Action potentials can be initiated at
A. the axon hillock B. nodes along the axon
C. A only D. both A and B

_____ 7. Which of the following is an inhibitory neurotransmitter?
A. GABA B. Acetylcholine
C. Norepinephrine D. Epinephrine

_____ 8. Which of the following control the "fight or flight" response?
A. parasympathetic nervous system B. sympathetic nervous system
C. somatic nervous system D. central nervous system

_____ 9. Humans rely most on this sense
A. smell B. hearing
C. vision D. taste

_____ 10. Photoreceptors in the eye are found
A. on the cornea B. in the lens
C. in the retina D. in the iris

Structure of the Neuron – Matching (2 points each)

_____	11. Soma	A. space between neurons
_____	12. Dendrites	B. site where neurotransmitter are released from
_____	13. Axon	C. cell body
_____	14. Synapse	D. receive information from nearby neurons
_____	15. Synaptic terminal	E. propagates the action potential

Neuroglia – Matching (2 points each)

_____	16. Microglia	A. maintain blood-brain barrier
_____	17. Schwann cells	B. cover somata in ganglia
_____	18. Oligodendrocytes	C. myelinate axons of PNS
_____	19. Astrocytes	D. myelinate axons of CNS
_____	20. Satellite cells	E. remove debris and waste

Ion Channels – Matching (2 points each)

_____	21. Mechanically regulated channels	A. allow diffusion of ions
_____	22. Passive channels	B. occur in sensory receptors
_____	23. Voltage regulated channels	C. depends on membrane potential
_____	24. Chemically regulated channels	D. requires binding of a specific molecule

Brain Organization – Matching (2 points each)

_____	25. Cerebellum	A. secretes melatonin
_____	26. Cerebrum	B. controls thinking
_____	27. Hypothalamus	C. controls internal organs
_____	28. Pineal gland	D. regulates body temperature
_____	29. Medulla oblongata	E. coordinates movement

True/False (2 points each)

_____ 30. Equilibrium is regulated by the cochlea.

_____ 31. The iris is a muscle that controls pupil size.

_____ 32. Cones detect color, and rods detect black/white images.

_____ 33. Nociceptors detect pain, and thermoreceptors detect vibration.

_____ 34. Olfaction often sparks an emotional response.

_____ 35. The only taste sensations are salt, sour, sweet, and bitter.

_____ 36. The cerebellum is the largest section in the brain.

_____ 37. Innate reflexes are learned throughout life.

_____ 38. Gray matter is nerve tissue, while white matter is bone tissue.

_____ 39. Serotonin levels influence migraine headaches.

_____ 40. Multiple sclerosis results from disintegration of myelination.

Short Answer (5 points each)
41. Draw and label a neuron.

42. Describe the differences between the sympathetic and parasympathetic nervous systems.

Anatomy and Physiology I Laboratory
Syllabus

The purpose of the anatomy and physiology lab is to give the student a practical application to the concepts learned in the lecture. Applying concepts of anatomy and physiology concepts to the real world gives us fields such as medicine and related areas.

The material for this course is difficult, and the labs can be time consuming. It will be to your benefit that you read over the lab and answer the pre-lab questions before coming to class each week.

Required Text: Fundamentals of Anatomy and Physiology Laboratory Manual, fourth edition
Authors: Meehan and Martini

Grading will be as follows:

Weekly lab participation	100 pts.
Weekly lab quizzes	90 pts.
Lab final exam	100 pts.
Total points	290 pts.

Weekly lab participation: This grade includes attendance in class and questions that are answered for each lab. One lab grade will be dropped. You may tear out the lab sheet from your lab manual, or you may answer the questions on your own paper to turn in.

Weekly lab quizzes: Quizzes will be given weekly covering the previous week's lab. This is designed to help you better understand the material. One quiz grade will be dropped.

Final exam: The final exam will be comprehensive. The questions on the final will come mainly from lab quizzes.

The semester grade will be determined as follows:

A 259-290 points
B 231-258 points
C 202-230 points
D 173-201 points
F below 173

Lab 1
Introduction to Anatomy and Physiology

The purpose of this lab is to familiarize the student with the equipment and procedures in the anatomy and physiology lab. The lab will cover safety, equipment, and general terms in anatomy and physiology.

Safety

Read pages 2-3 on safety in the laboratory manual and answer the following questions.

1. Draw a diagram of the lab room. On your diagram label the location of the fire extinguisher, fire blanket, eye wash, and shower.

2. Draw the safety code in Figure 1-1 on page 3. Label what each section of the diamond represents.

3. What level of risk do the following numbers represent, if found on the safety code.
   0=______________________ 3=_________________________
   1=______________________ 4=_________________________

Lab Equipment
Look at pages 3-4 in the laboratory manual that describes laboratory equipment. Answer the following questions.

4. What piece of lab equipment would you use if you were asked to measure 10 ml of distilled water?

5. Why shouldn't you use a beaker for measuring a specific volume of liquid?

The Metric System
All measurements in the lab are recorded using the metric system. Look over pages 8-9 and answer the following questions.

6. One kilogram contains ________________ milligrams.

7. One centiliter contains _______________ milliliters.

8. A micrometer is one ________________ of a meter.

Anatomical Orientation and Terminology
Standard terms and orientations are always used in anatomy and physiology to ensure continuity. Using pages 24-31 and pages 49-59, answer the following questions.

9. Describe anatomical position.

10. Directional terms refer to the (observer or person being observed) circle one.

11. The appendix, small intestine, and right ovary are found in the ______________ quadrant.

Lab 2
Active and Passive Transport

This lab examines how materials travel into and out of cells across the cell membrane. Cells require these processes in orders to receive the oxygen and nutrients they need.

Pre-Lab Activity – Read lab exercise 9 on pages 72-80 in the laboratory manual, and answer the following questions.

- What are the two methods that allow substances to move into and out of cells?
- What is the difference between active and passive transport?
- What is diffusion?
- How is osmosis different from diffusion?
- Name one way to demonstrate diffusion.

Lab Activity – Follow the listed procedures, and fill in all data tables and answer the questions pertaining to each lab.

1. Begin with the procedure for experiment #6: Osmosis (Artificial Cell) on page 77. At the end of the lab period, you will complete this experiment.
2. Follow the procedures for the experiment on active transport.
3. Follow the procedures for experiments #2 and #3 under passive transport.
4. Follow procedures for experiment #7: Osmosis (Red Blood Cells) on page 78.

Post -Lab Activity – Answer these questions after completing the lab activity.

- What is Brownian movement?
- What will happen if an artificial cell containing 40% sugar solution is placed in distilled water?

- Know the difference between hypertonic, isotonic, and hypotonic.

- What will happen to a red blood cell if it is placed in a hypotonic solution?

Lab 3
Histology

The purpose of this lab is to examine the various tissue types in the body. After doing this lab, the student should be able to identify tissue types under the microscope.

Pre-Lab Activity – Read lab exercise 11 on pages 91-99 in the laboratory manual, and answer the following questions.

- What is histology?
- What are the four main tissue types?
- What is the function of the four main tissue types?
- What does keratinized mean?
- What are the three types of muscle tissue?

Lab Activity – Follow the procedures for the lab beginning with the Epithelial Tissue on page 92. You may obtain slides and sketch what you see for each type of tissue. Answer the questions that correspond with each slide.

Post-Lab Activity – After completing the lab, answer the following questions.

- Be able to identify the various tissue types from viewing a slide.
- What tissue type provides a lining in the walls of the esophagus?
- What type of tissue makes up tendons and ligaments?
- What type(s) of muscle tissue lack(s) striations?

Lab 4
Integument

This lab looks at the structure and function of the integumentary system. The integumentary system includes the skin and the glands associated with the skin.

Pre-Lab Activity – Read lab exercise 13 on pages 109-116 in the laboratory manual, and answer the following questions.

- What are some functions that the integument provide?
- What are the three main subdivisions of the integument?
- What does melanin do?
- What are the layers of the epidermis?
- What glands are contained in the integumentary system?

Lab Activity – Follow all procedures in the lab exercise. Draw sketches and answer questions where needed.

Post-Lab Activity – Answer the following questions after completing the lab.

- Why is it beneficial to have thick skin on the palms?
- Be able to differentiate between the sebaceous and apocrine glands under the microscope?
- Why is it beneficial to have keratinized skin?
- What are formed by epidermal ridges?

Lab 5
Skeletal Overview and Terminology

This lab examines general bone structure and terminology. The student should be able to identify internal and external bone structures along with various bone types.

Pre-Lab Activity – Read exercises 14 and 15 on pages 117-132 in the laboratory manual, and answer the following questions.

- What connective tissues are found in the skeleton?
- What is the difference between spongy and dense bone?
- What function does bone marrow have?
- Name three ways we classify bones.
- Why is it important to understand skeletal terminology?

Lab Activity – In exercise 14, follow the lab procedure, draw the needed sketches, and answer the questions. For exercise 15, begin applying the terminology about the skeleton by including it in your conversation. Observe the terms on actual bones so that they become familiar.

Post-Lab Activity – After completing the lab, answer the following questions.

- How are bone and cartilage different?
- Why do you think cartilage heals more slowly than bone?
- Be able to identify and give examples of the various bone shapes?

Lab 6
Axial and Appendicular Skeletons

The human skeleton can be divided into the axial and appendicular skeletons. This lab examines the different components of each.

Pre-Lab Activity – Read exercises 16 and 17 on pages 133-158 in the laboratory manual, and answer the following questions.

- What are the three major components of the axial skeleton?
- Why is the cranium important?
- What function does bone marrow have?
- What divisions make up the appendicular skeleton?

Lab Activity – Following the lab manual, examine the human skeleton in detail. Fill in the answers and charts within each exercise.

Post-Lab Activity – Answer the following questions.

- Be able to identify major bones and their specific functions?
- Be able to identify major bone markings?

Lab 7
Articulations

Articulations join the bones of the skeleton. This lab examines the forms and functions of the various articulations in the body.

Pre-Lab Activity – Read exercise 18 on pages 159-169 in the laboratory manual, and answer the following questions.

- What are two ways that we classify joints?
- What are the various tissues that are found in joints?
- What function do tendons and ligaments have?
- What are freely movable joints called?

Lab Activity – Follow the procedures for exercise 18. Answer questions within the lab. Be sure to make note of the terminology associated with joint movement.

Post-Lab Activity – Answer the following questions.

- What are the different classifications of joints?
- Give examples of joints that have no movement, little movement, and free movement?
- Know the terms associated with joint movement.

Lab 8
Human Musculature

The human musculature involves three different forms of muscle tissue: skeletal, cardiac, and smooth muscle. This lab introduces the muscle types and the general muscular structure of the human anatomy.

Pre-Lab Activity – Read exercises 20-21 on pages 178-218 in the laboratory manual, and answer the following questions.

- What two muscle types are striated?
- What do intercalated discs do?
- Where do you find visceral smooth muscle?
- What is the origin and insertion of a muscle?

Lab Activity – Follow the procedures for exercises 20-21. Answer questions within the lab. You should start becoming familiar with the major muscles of the human anatomy.

Post-Lab Activity – Answer the following questions.

- Name the major muscle involved in these actions:
  Closing your eyes ____
  Kissing ____
  Shrugging your shoulders __________________________________
  Breathing (besides the diaphragm) __________________________
  Extending the calf ____
  Pulling in the stomach _____________________________________
- Which muscles originate on the:
  Scapula ____
  Occipital bone ____
  Cervical vertebrae ____

- Which muscles insert on the:

  Head of the fibula ____

  Coccyx ____

  Clavicle ____

Lab 9
Muscles and Exercise

This lab focuses on the complex process of muscle contraction. The lab also examines the effect that exercise has on muscle tissue.

Pre-Lab Activity – Read exercises 22-23 on pages 219-231 in the laboratory manual, and answer the following questions.

- What stimulates a muscle contraction?
- What does the sliding filament theory state?
- What does an electromyograph measure?
- What are endorphins?

Lab Activity – Follow the procedures for exercises 22-23. Answer questions within the lab. Answer the exercise experimentation questions in as much detail as possible.

Post-Lab Activity – Answer the following questions.

- Name three beneficial effects of exerting stress on muscles.
- What is the membrane potential?

Lab 10
The Human Brain

This lab looks at the anatomy and physiology of the human brain. The student should become familiar with the general anatomy of the brain. Brain physiology will be studied through electroencephalography.

Pre-Lab Activity – Read exercises 30-31 on pages 309-323 in the laboratory manual, and answer the following questions.

- Know the function and location of the following:
  Sulcus
  Gyrus
  Fissure
  Cranial nerve
  Cerebrum
  Cerebellum
  Hemisphere
  Corpus callosum
  Pons
  Medulla

- What is electroencephalography?

Lab Activity – Follow the procedures for exercises 30-31. Answer questions within the lab.

Post-Lab Activity – Answer the following questions.

- Why is meningitis dangerous?

- Know what each of the following represent.
  Alpha waves ____
  Beta waves ____
  Delta waves ____
  Theta waves ____

Lab 11
Sensory System

The sensory system of the body allows humans to react to the outside environment. Reacting to the environment is necessary for life. If one sensory system fails, the other senses must compensate for the loss. The lab examines the various components of the sensory system.

Pre-Lab Activity – Read exercises 36, 38, 39, 40, 41, and 42 beginning on page 361 in the laboratory manual. Answer as many questions within the lab exercises as possible.

Lab Activity – Follow the procedures for the exercises listed above. You will work with your partner through each exercise and record your results to the best of your ability. Remember that these labs are not used to diagnose medical problems.

Post-Lab Activity – After completing these lab exercises, you should know the general structures with each of the sensory organs. You should also be familiar with methods for testing and individual's ability to use each sense organ.

Name ______________________________ Section __________ Date ______________

Lab Quiz 1

Answer the following questions with the best answer.

1. List four safety procedures that should be followed in the lab (1 point each).

2. One kilogram contains ___________________ milligrams.

3. One centimeter contains __________________ millimeters.

4. Describe anatomical position.

5. What piece of equipment would you use to measure 10 ml?

6. How can you know how to handle certain chemicals in the lab?

7. Would you use a beaker to measure large amount of liquid (500 ml)? Why or Why not?

Name ______________________________ Section __________ Date ______________

Lab Quiz 2

Answer the following questions with the best answer.

1. What type of transport requires energy?

2. One drop of colored dye spreads through a glass of distilled water because of ____________________.

3. What happens to a red blood cell when it is placed in a hypertonic solution?

4. What happens to a red blood cell when it is placed in hypotonic solution?

5. Why does Brownian movement occur?

6. What energy source was used in the active transport experiment?

7. How is osmosis different from diffusion?

8. What piece of lab equipment did you use to measure fluids?

9. What happens if your blood is not an isotonic solution?

10. Why are red blood cells influenced by the solution they are in?

Name ______________________________ Section __________ Date ______________

Lab Quiz 3

Answer the following questions with the best answer.

1. Name 2 of the 4 tissue types.

2. What is histology?

3. ___________________ tissue provides a lining for internal organs.

4. Name one place where you would find smooth muscle tissue.

5. What kind of tissue is seen in slide #1?

6. What kind of tissue is seen in slide #2?

7. What is one function of connective tissue?

8. What is adipose tissue more commonly known as?

9. What is one specific type of connective tissue?

10. What is neural tissue?

Name ______________________________ Section __________ Date ______________

Lab Quiz 4

Answer the following questions with the best answer.

1. What are three components of the integumentary system?

2. Which has thicker skin, the palm of the hands or the forearm?

3. An individual's fingerprints are determined by ___________________________.

4. How can skin color change?

5. Why are parts of the integument keratinized?

6. What part of the integumentary system is found in the slide?

7. How are apocrine glands different from merocrine?

8. What are the two main divisions of the skin?

9. Name two reasons why the skin is so important?

10. Name two glands found in the skin.

Name ______________________________ Section __________ Date ______________

Lab Quiz 5

Answer the following questions with the best answer.

1. What is the importance of bone marrow?

2. What are two ways that bones are identified?

3. How would you describe the shape of bone #1?

4. How would you describe the shape of bone #2?

5. What is one difference between bone and cartilage?

6. Torn cartilage takes longer to heal than a broken bone. Why?

7. The marking labeled A on bone #3 is called a ______________________________.

8. The marking labeled B on bone #3 is called a ______________________________.

9. If something is located lateral to an object, where is it in relation to that object?

10. Why is it important to know skeletal terminology?

Name ______________________________ Section __________ Date ______________

Lab Quiz 6

Answer the following questions with the best answer.

1. What are the major components make up the axial skeleton?

2. Why is bone marrow important?

3. What does the sternum do?

4. What function do the ribs provide?

5. What are the three bones of the leg (3 points)?

6. Where is the scapula found?

7. Where is the ulna found?

8. Where would you find the metatarsals?

Name ______________________________ Section __________ Date ______________

Lab Quiz 7

Answer the following questions with the best answer.

1. Name one way we classify joints?

2. What function do tendons provide?

3. What function do ligaments provide?

4. Name an example of a ball-and-socket joint?

5. Where do you find immovable joints?

6. Doing a bicep curl is an example of what type of movement in the elbow joint?

7. The elbow is what type of joint?

8. What do you think happens if there is a lack of cartilage in a joint?

9. The vertebrae are joined by what type of articulation?

10. Why is it beneficial that vertebral movement is limited?

Name ______________________________ Section __________ Date ______________

Lab Quiz 8

Answer the following questions with the best answer.

1. What type of muscle is striated and contains intercalated discs?
2. What type of muscle is found in the stomach?
3. Why are intercalated discs important?
4. What type of muscle tissue controls arm movements?
5. What is the origin of a muscle?
6. What is the insertion of a muscle?
7. What major muscle is involved in kissing?
8. What major muscle shrugs the shoulders?
9. Name one muscle that originates on the scapula.
10. Name one muscle that inserts on the coccyx.

Name ______________________________ Section __________ Date ______________

Lab Quiz 9

Answer the following questions with the best answer.

1. What theory describes muscle contraction?

2. What does and electromyograph measure?

3. What initiates a muscle contraction?

4. What are endorphins?

5. Name two reasons why exercise is beneficial.

6. What happens to muscle when they are continually exercised?

7. How is membrane potential created?

8. What is stress as related to exercise?

9. Acetylcholine is an example of what type of chemical?

10. What is exercise?

Name ______________________________ Section __________ Date ______________

Lab Quiz 10

Answer the following questions with the best answer.

1. What is a sulcus?

2. What is a gyrus?

3. What is the largest portion of the brain?

4. The brain is divided into _____________ and ______________ hemispheres.

5. What is electroencephalography?

6. What do alpha waves signify?

7. What do beta waves signify?

8. What is meningitis?

9. Where is the cerebellum located?

10. What does the corpus callosum do?

Name ________________________________ Section ______ Date ____________

Anatomy and Physiology I
Lab Final Exam

Answer the following questions with the best answer. The point value for each question is in parentheses after each question.

1. List three safety procedures that should be followed in the lab. (6)

2. List what lab piece of lab equipment you would use to do each of the following procedures. (3)

   Measure 5 mg of NaCl ______________________________________

   Observe a smooth muscle cell ________________________________

   Measure 500 ml of distilled water ____________________________

3. Name two different forms of passive transport. (2)

   ________________________ ________________________

4. What will happen to a red blood cell if it is placed in the following solutions: (6)

   Hypertonic ___________________________

   Hypotonic ___________________________

   Isotonic ____________________________

5. Draw a person in anatomical position. (4)

6. What type of tissue is in slide #1? (4)

7. What type of tissue is in slide #2? (4)

8. Why is your skin keratinized? (2)

9. What are the two subdivisions of the skin? (4)

10. Name the shape of bone #1. (2)

11. Name the shape of bone #2. (2)

12. The marking labeled A on bone #3 is called a ______________________________. (2)

13. The marking labeled B on bone #4 is called a ______________________________. (2)

14. Why is it important to know skeletal terminology? (4)

15. Why is bone marrow important? (2)

16. Name a specific joint for each of the following types. (6)

Ball-and-socket ____________________________________

Hinge ____

Immovable ____

17. What type of muscle tissue is shown is slide #3? (4)

18. What type of muscle tissue controls the digestive organs? (2)

19. What type of muscle tissue is striated and contains intercalated discs? (2)

20. What type of muscles control shoulder movement? (2)

21. What major muscle is used when kissing? (3)

22. What muscle is used when pulling in the stomach? (3)

23. Which muscle originates on the occipital bone? (3)

24. What muscle inserts on the clavicle? (3)

25. Name three benefits of exercise on muscle tissue. (6)

26. What does and electromyograph measure? (4)

27. What do the following represent? (4)

Alpha waves ________________________________

Beta waves __________________________________

Delta waves _________________________________

Theta waves _________________________________

28. What is an astigmatism caused by? (3)

29. What function does the external ear provide? (2)

30. What part of the human anatomy is responsible for equilibrium? (2)

31. Name one way to test a person's equilibrium? (2)

Anatomy and Physiology II
Course Syllabus

Anatomy and physiology provides a general overview and introduction to the human body. The content in the course examines each of the body systems, and how they function together to maintain proper body functioning.

Because the content within this course is difficult, attendance is crucial. A student manual will be available to guide you in taking notes. There will be three examinations, and a non-comprehensive final. The exams have equal weight in determining the semester grade.

Exam I	= 100 pts.
Exam II	= 100 pts.
Exam III	= 100 pts.
Final	= 100 pts.

Week 1
Lecture 1 The Endocrine System
Lecture 2 The Endocrine System
No lab

Week 2
Lecture 3 Adrenal Glands
Lecture 4 The Endocrine System
Lab 1

Week 3
Lecture 5 Endocrine Disorders
Review
Lab 2

Week 4
Exam I
Lecture 6 Blood
Lab 3

Week 5
Lecture 7 Blood
Lecture 8 The Heart
Lab 4

Week 6
Lecture 9 Circulation
Lecture 10 Cardiovascular Physiology
Lab 5

Week 7
Review
Exam II
Lab 6

Week 8
Lecture 11 Lymphatic System and Nonspecific Immunity
Lecture 12 Specific Immune Response
Lab 7

Week 9
Lecture 13 General Anatomy of the Respiratory System
Lecture 14 The Lungs
Lab 8

Week 10
Lecture 15 Process of Respiration
Review
Lab 9

Week 11
Exam III
Lecture 16 The Digestive System
Lab 10

Week 12
Lecture 17 The Digestive System
Lecture 18 The Digestive System
Lab 11

Week 13
Lecture 19 Urinary System and Kidney Function
Lecture 20 Renal Physiology
Lab Review

Week 14
Lecture 21 Male Reproductive System
Lecture 22 Female Reproductive System
Lab Final

Week 15
Review
Review

Week 16
Final Exam

Lecture 1
The Endocrine System

I. Cellular Communication

In order for the human body to function, cells must communicate with one another. There are four types of communication between cells.

A. Direct communication occurs at gap junctions between adjacent cells. Gap junctions occur in epithelial, cardiac, and neural tissue.

B. Paracrine communication occurs in a local area by paracrine factors. These are chemical messengers that are released by all cells and attach to specific receptor sites in the surrounding tissue.

C. Endocrine communication involves chemical messengers that travel by way of the circulatory system. Hormones, the chemical messengers, are produced in specialized cells. When released hormones travel in the circulatory system until they reach their specific receptor site in another tissue.

D. Synaptic communication occurs in neural tissue, which also involves chemical messengers that travel between neurons across the synaptic cleft.

II. Chemical Structure of Hormones

The hormones in the endocrine system are produced in specialized secretory glands. The hormones produced can be divided into three groups based on the chemical structure of the chemical.

A. Hormones that have a structure similar to amino acids are known as amino acid derivatives. Within this group are the catecholamines that include epinephrine, norepinephrine, and dopamine. The thyroid hormones and melatonin, produced in the pineal gland are also considered amino acid derivatives.

B. Chains of amino acids make up the peptide hormones, which are divided into two smaller groups of hormones. One group is made up of short peptide chains (ADH and oxytocin) and small proteins (growth hormone). The hypothalamus, posterior and anterior pituitary gland, heart, thymus, digestive tract, and pancreas all produce hormones within this group. Glycoproteins make up the second group of peptide hormones. These hormones have a long chain of 200 or more amino acids and have side chains of carbohydrates. Some hormones produced in the anterior pituitary gland, such as thyroid-stimulating, lutenizing, and follicle-stimulating hormones are in this group.

C. Hormones that are lipid derivatives are divided into two smaller subdivisions: steriod hormones and eicosanoids. Steroid hormones are structured similar to cholesterol and are produced by the reproductive organs, the kidneys, and the adrenal glands. Eicosanoids have a five carbon ring at one end and can act as paracrine or endocrine factors. Leukotrienes and prostaglandins are important eicosanoids.

III. Hormone Transport

When hormones are released, they enter the bloodstream and travel either freely or are bound to carrier proteins. Freely circulating hormones are active for only short periods of time and then are either diffused out of the bloodstream to target receptors, absorbed and broken down by the liver or kidneys, or broken down by enzymes in the blood plasma or interstitial fluid. Steroid and thyroid hormones bind to carrier proteins in the bloodstream and remain in circulation for longer periods of time than the free-circulating hormones.

IV. Hormone Function

All cells are made up of and operated by proteins. Structural proteins make up the structure of the cell and enzymes run the activities of the cell. Hormones alter these cellular proteins, which allows the cell to perform varied functions. Hormones can stimulate a cell to make an enzyme or structural protein by turning on specific genes, activate or deactivate a specific enzyme within a cell, or increase or decrease the production of a specific enzyme. In order for a hormone to have one of these effects on a cell, it must first enter the target cell. Hormones do this in one of two ways.

A. Steroid and thyroid hormones are lipid-soluble hormones that pass through the cell membrane of target cells and bind to receptor sites within the cytoplasm. Once the hormone has bound to the receptor site, this complex then binds to a hormone-responsive element (HRE). This HRE then activates or inactivates certain genes in the nucleus that alter protein production.

B. Other hormones bind to receptor sites in the cell membrane. Catecholamines and peptide hormones are not lipid soluble and cannot penetrate the cell membrane. Therefore, they bind to receptor sites on the membrane. Eicosanoids, which are lipid-soluble pass through the cell membrane and bind to receptor sites on the inner side of the membrane. The binding of these hormones to receptor sites activates a second messenger system.

Lecture 2
The Endocrine System

I. Control of the Endocrine System

In order for the endocrine system to be effective, there must be mechanisms in the body to trigger the release and activation of hormones. These mechanisms are called endocrine reflexes.

A. Endocrine reflexes trigger hormone production usually as a negative feedback system. In this case, a stimulus activates a hormone that will counteract and decrease the intensity of that stimulus. Simple endocrine reflexes involve only one hormone, while more complex endocrine reflexes involve more than one hormone and the nervous system.

B. The activities of the hypothalamus involve complex endocrine reflexes. The hypothalamus can release hormones that trigger hormones in the pituitary gland. Then, the hypothalamus can also trigger hormone production in the adrenal medullae by the autonomic nervous system.

C. Neuroendocrine reflexes involve both hormones and neurons as a means of control.

II. The Pituitary Gland

The pituitary gland, located in the brain, is an important gland that releases nine different hormones. The anterior pituitary releases seven different hormones, and the posterior pituitary releases two different hormones.

A. The following hormones are secreted from the anterior pituitary.

1. Thyroid-stimulating hormone (TSH) triggers the release of thyroid hormones from the thyroid gland.

2. Adrenocorticotropic hormone (ACTH) targets the adrenal cortex and stimulates it to release glucocorticoids.

3. Follicle-stimulating hormone (FSH) targets the ovaries and testes. This hormone stimulates follicle development and sperm maturation

4. Lutenizing hormone (LH) targets the ovaries and testes and stimulates ovulation and testosterone secretion.

5. Prolactin triggers milk production in the mammary glands.

6. Growth hormone triggers growth in all cells.

7. Melanocyte-stimulating hormone (MSH) triggers the production of melanin in the epidermis.

B. The following hormones are produced in the posterior pituitary gland.

1. Antidiuretic hormone (ADH) targets the kidneys triggers the reabsorption of water.

2. Oxytocin triggers labor contractions and milk ejaculation.

III. The Thyroid Gland

The thyroid gland in the neck produces thyroxine and calcitonin. Thyroxine targets the majority of cells and increases energy use and triggers growth and development. Calcitonin travels to the bones and kidneys and triggers the decrease in calcium ion concentrations in bodily fluids.

IV. The Parathyroid Gland

The parathyroid gland secretes a hormone known as parathyroid hormone (PTH). This hormone also affects calcium ion concentrations. It stimulates osteoclasts, while inhibiting osteoblasts. PTH also inhibits the excretion of calcium ions in the urine.

V. The Thymus

The thymus, which is located posterior to the sternum, produces hormones that are important for proper development of the immune system. Thymosins, the hormones produced, target the lymphocytes. The thymus is larger in children and grows at a slightly slower rate than the body during development. At puberty, the thymus stops growing and begins to lessen in size. The decreased size of the thymus in the elderly may partially explain the higher occurrence of disease in older adults.

Lecture 3
The Adrenal Glands

I. The Adrenal Glands

The adrenal glands are located between the top of the kidney and the diaphragm at approximately the twelfth rib. The adrenal glands have two major sections called the adrenal cortex and the adrenal medulla.

A. The adrenal cortex is made up of lipids and fatty acids that give it a yellowish color. The specific layers of the adrenal cortex produce corticosteriods that are necessary for life.

   1. The zona glomerulosa is the outer layer of the adrenal cortex where the cells form little clusters or balls (glomerulus means "ball"). This region produces mineralcorticoids that regulate electrolyte levels. The most important of these is aldosterone. Aldosterone works to retain sodium ions in sweat, urine, and saliva, and it helps to eliminate potassium ions.

   2. The zona fasciculata makes up the majority of the adrenal cortex and produces glucocorticoids. ACTH from the anterior pituitary gland activates the production of mostly cortisol, and smaller amounts of corticosterone and cortisone. Glucocorticoids have several effects on the body. They increase the synthesis of glucose and speed the breakdown of fatty acids. Glucocorticoids also act to decrease inflamation in allergic reactions, but as a result weaken the immune system.

   3. The zona reticularis borders the adrenal medullae and produces androgens from the branched and folded endocrine cells. These androgens are produced in larger amounts in the testes, and are converted to estrogens in females. The effect of this hormone production is uncertain.

B. The adrenal medulla, the highly vascularized and reddish region of the adrenal gland, secretes epinephrine and norepinephrine. Secretions of these hormones are controlled by the sympathetic nervous system. Seventy-five percent of the hormones produced are epinephrine, but both hormones trigger alpha and beta receptors in cell membranes. Epinephrine and norepinephrine accelerate the breakdown of glucose and mobilize glycogen reserves. They increase the breakdown of fatty acids and increase heart rate.

II. The Kidneys

The kidneys also release the hormones, calcitriol and erythropoietin, and the enzyme renin.

A. Calcitriol is produced by the kidneys when PTH and cholecalciferol are present. Calcitriol acts in aiding calcium and phosphate ion absorption.

B. Erythropoietin, produced in the kidneys, activates the production of red blood cells in the bone marrow. The hormone is secreted when oxygen levels are low in the kidneys. Oxygen levels may drop for several reasons: reduced blood flow, reduced number of red blood cells, or a lack of oxygen in the lungs.

C. Renin, part of the renin-angiotensin system, is produced in the juxta-glomerular apparatus in the kidney and is sometimes considered a hormone. Renin production increases as a result of sympathetic stimulation or by a decrease in renal blood flow. Renin acts by converting angiotensinogen to angiotensin I. Then angiotensin I is converted to angiotensin II. Angiotensis II increases aldosterone production, stimulates ADH production, stimulates thirst, and constricts blood vessels.

III. The Heart

The heart contains endocrine cells in the walls of the atria. These cells act in response to increased blood volume and produce the hormone atrial natriutetic peptide (ANP). ANP acts opposite to angiotensin II.

IV. The Pancreas

The pancreas, which will be discussed in detail in the lectures on the digestive system, produces two hormones that have a widespread effect on the body. The pancreas is divided into pancreatic islets that contain four different cell types. These cell types produce the pancreatic hormones.

A. Alpha cells produce glucagon, which stimulates glycogen breakdown in the liver and skeletal muscle, and causes an increase of glucose in the blood. The pancreas secretes glucagon when the glucose levels in the blood fall below normal. Glucagon attaches to receptor sites in the cell membrane and activates a cAMP second messenger system. Glucagon also activates triglyceride breakdown, so that fatty acids can be used by other tissues. It also activates gluconeogenesis in the liver, which is the conversion of amino acids into glucose.

B. Beta cells produce insulin, which is a hormone that acts to lower the glucose levels in the blood. When glucose levels increase, insulin activates the uptake of glucose in the cells of the body. Insulin also increases the production of glycogen in the skeletal muscles and the liver, and it stimulates the formation of triglycerides in adipose tissues.

C. Delta cells produce a hormone identical to somatostatin, which inhibits the secretion of glucagon and insulin and slows food absorption in the digestive tract.

D. F cells produce pancreatic polypeptide hormone, whose specific function is unknown. It prevents gallbladder contractions and regulates pancreatic enzymes.

Lecture 4
The Endocrine System

I. The Reproductive System

Hormones that regulate the reproductive system are produced in the pituitary gland, but hormones are also produced in the reproductive organs of the male and female.

A. Androgens are produced in the interstitial cells of the male testes. The most influential androgen produced is testosterone, which has many functions in the male. Testosterone is responsible for the following: production of sperm, stimulation of growth, growth of facial hair, distribution of body fat, growth of muscles, production of aggressive behavior, and influence on the CNS during embryonic development. Sustentacular cells secrete inhibin when stimulated by FSH. Inhibin supresses the secretion of FSH and GnRH.

B. The ovaries in the female produce hormones in conjunction with hormones from the pituitary gland. Oocytes are carried in follicles, which develop through FSH stimulation. The cells within the follicle then produce estrogens, primarily estradiol, which enhance maturation of the oocytes and stimulate growth of the uterine lining. Follicle cells also secrete inhibin to suppress the anterior pituitary, similar to the inhibin in males. During the ovarian cycle, LH creates the corpus luteum from the follicle. The cells in the follicle then produce progestins. Progestins prepare the uterus for the embryo, speed movement of the oocyte or embryo in the uterine tube, and increase the size of the mammary gland. Relaxin is also produced by the placenta, corpus luteum, and uterus during pregnancy. Relaxin aids in expanding the uterus and vagina in preparation for delivery.

II. The Pineal Gland

The pineal gland is a small gland that produces the hormone, melatonin. Melatonin is produced mainly at night and less during daylight hours. Melatonin has several functions in the body. It slows the sexual maturation process by inhibiting the secretion of GnRH, which affects the onset of puberty. Melatonin is an antioxidant that protects the CNS from free radicals. Because the production of melatonin depends on the light-dark cycle, it is believed that it affects the circadian rhythms of physiological activities. It is also believed that melatonin is associated with seasonal affective disorder (SAD).

III. Interaction of Hormones

Hormones are continually being released into the bloodstream in varying concentrations. There are four possible results that can occur when a cell receives a signal from two hormones. When two opposing hormones act on a cell, the impact of the stronger hormone will be less because of the influence of the opposing hormone. In a synergistic combination the hormones have an additive effect and the result is greater than one hormone acting alone. A permissive effect occurs when the first hormone is needed for the second hormone to have an effect. Hormones can also have different effects that complement one another.

IV. Hormonal Effect on Growth

Several hormones influence the rate of growth of the human body.

A. Growth hormone regulates glucose levels in the blood and lipid reserves in adipose tissue. In children, GH affects protein synthesis and cellular development, which creates muscular and skeletal tissue.

B. Thyroid hormones are required for proper development of the nervous system and skeletal system.

C. Insulin is needed for cells to receive the glucose and amino acids necessary for growth.

D. Parathyroid hormone and calcitriol are needed to ensure that the necessary amount of calcium is deposited in bone tissue. A lack of these hormones will result in weak bones.

E. Hormones produced in the reproductive system of both males and females are responsible for the proper formation of sexual characteristics.

V. Stress

Stress is anything that alters the physiological response in the body. Stressors can be emotional, physical, environmental, or metabolic, and the body responds to any of these stressors, which is known as the general adaptation syndrome (GAS). GAS has three phases: the alarm phase, the resistance phase, and the exhaustion phase.

A. The alarm phase is activated by the sympathetic nervous system in the presence of a stressor. In this phase epinephrine, the primary hormone involved, creates several responses of “fight-or-flight.” These responses include increased mental awareness, increased energy consumption, breakdown of glycogen and lipids, increased blood flow to muscles, decreased blood flow to kidneys, skin, and digestive organs, reduction in digestion and urination, increase in sweat secreation, increase in heart rate, blood pressure, and respiratory rate.

B. The resistance phase begins if the stress is not relieved after a period of several hours. If the resistance phase is reached more energy must be created than was given in the alarm phase, and glucocortocoids become the primary hormone involved. Glucocortocoids stimulate adipose tissues to break down fatty acids for energy and stimulate skeletal muscles to release amino acids for energy. Because the fatty acids are used for energy, the glucose level in the bloodstream remains stable. The glucocortocoids also stimulate the liver to produce more glucose to ensure that the glucose in the blood remains at a normal level. Water and salts are also conserved to maintain blood volume.

C. If the resistance phase persists lipid reserves are exhausted and structural proteins are then broken down. The resistance phase then ends and the exhaustion phase begins. In this phase ion concentrations are greatly distorted and major organ systems begin to fail because neurons and muscle fibers can not function properly.

Lecture 5
Endocrine Disorders

I. Acromegaly

Acromegaly results when there is an increase in the production of growth hormone (GH). The increase in GH causes an increase in bone mass and weight, and during development it can result in gigantism. After puberty, the overproduction of GH causes increased bone and cartilage growth making features more pronounced.

II. Pituitary Growth Failure

Pituitary growth failure, know as dwarfism, is caused by a lack of GH. During development this lack of GH prevents normal bone and cartilage growth and bones remain short. Few children suffer from this disorder in the U.S. because GH can be administered to incur normal bone growth.

III. Diabetes Insipidus

Diabetes insipidus is caused by a decrease in the amount of ADH secreted by the posterior pituitary gland. The kidneys are no longer able to conserve water, which is then lost in the urine. The person is continuously thirsty and may not need treatment is the proper electrolyte balance can be maintained.

IV. Diabetes Mellitus

Diabetes Mellitus occurs when glucose levels in the blood are too high. Therefore, glucose is lost in the urine, along with a higher level of fatty acids. Diabetes can be insulin-dependent (Type I) or non-insulin-dependent (Type II). Diabetes Mellitus can be caused by a variety of factors, but usually results in chronic health problems.

V. Hypothyroidism

Hypothyroidism results when there is a lack of thyroid hormones. In infants, this disorder prevents normal skeletal and nervous system development causing growth and mental retardation known as cretinism. In adults, some symptoms include weak muscles, slow reflexes, and hair loss.

VI. Hyperthyroidism

Hyperthyroidism occurs when there is an increase in the production of thyroid hormones. This results in a higher metabolic rate and an increase in heart rate and blood pressure. Even though the person is more excitable, those with hyperthyroidism tire easily.

VII. Hypoparathyroidism

In hypoparathyroidism a decrease in parathyroid hormones decreases the amount of calcium ions in the bloodstream. This mainly affects the neural and muscular system, and prolonged muscle spasms are common.

VIII. Hyperparathyroidism

In hyperparathyroidism an increase in parathyroid hormones causes an increase of calcium ions in the bloodstream. This results in weakened bone and muscle tissue.

IX. Hypoaldosteronism

In hypoaldosteronism not enough aldosterone is produced in the zona glomerulosa of the adrenal cortex. An excess of water and sodium ions are lost in the urine causing an electrolyte imbalance that disrupts action potentials in neural and muscular tissue.

X. Aldosteronism

Aldosteronism occurs when an excess of aldosterone causes the kidneys to retain sodium ions and eliminate an excess of potassium ions. This again disrupts membrane potentials.

XI. Addison's Disease

Addison's disease is a rare disease in which insufficient glucocorticoids are produced in the zona fasciculata of the adrenal cortex. It is caused usually either by an autoimmune response or by and infection of tuberculosis. Symptoms include tan skin, weakness, and weight loss.

XII. Cushing's Disease

Cushing's disease is a result of an excess of glucocorticoids. In this disease the metabolism of glucose is decreased and the breakdown of lipids increase. Body fat is redistributed and the face often gets fuller because of and increase in fat deposition.

XIII. Andrenogenital Syndrome

Andrenogenital syndrome results when an abnormal amount of androgens are produced in the zona reticularis of the adrenal cortex. Tumors in this region can cause an increase of hormones. In males it can cause an increase in estrogen production, leading the formation of female secondary sexual characteristics. In females it can cause an increase androgens and the formation of male secondary sexual characteristics.

XIV. Goiter

If an iodine deficiency occurs, it can lead to an excess secretion of thyroid hormones and an enlarged thyroid.

Lecture 6
Blood

I. Introduction to Blood

In complex organisms, blood is necessary to carry out many vital functions. Blood transports gases, nutrients, hormones, and wastes throughout the body. Blood regulates ions to maintain a balanced pH and electrolyte concentration. Specific cells in the blood clot when an injury occurs to prevent excess blood loss. White blood cells in the blood fight pathogens in the body. Blood helps to regulate body temperature by redistributing temperature to various area of the body. Blood is made up of various components: plasma, red blood cells, white blood cells, and platelets.

II. Plasma

Plasma, which is 92 percent water, makes up approximately 50 percent of whole blood. Plasma contains three categories of plasma proteins: albumins, globulins, and fibrinogens.

A. Albumins make up most of the plasma proteins and are the primary component creating osmotic pressure. Albumins also carry fatty acids, thyroid hormones, and some steroid hormones in the blood.

B. Globulins include immunoglobulins that form antibodies to fight off pathogens and other transport globulins. Transport globulins carry ions, hormones, or other compounds that might otherwise get excreted by the kidneys.

C. Fibrinogen proteins are strands of protein that provide framework for blood clots.

III. Red Blood Cells

Red blood cells, or erythrocytes, are the most numerous cell in the blood. They contain the red-pigmented hemoglobin that carries oxygen and carbon dioxide in the bloodstream.

A. The red blood cells are the most numerous of the blood cells. Blood tests measure the amount of RBCs in a microliter/mm^3 of blood. For males, the average amount is 4.5-6.3 million RBCs in a microliter/mm^3. In females, the average amount is 4.2-5.5 million RBCs in a microliter/mm^3. Hematocrit refers to the amount of blood cells in whole blood and is determined by centrifuging whole blood. The hematocrit is referred to as the packed cell volume (PCV).

B. Red blood cells differ in appearance from most cells in the body. RBCs are biconcave discs that resemble a donut in appearance. This shape gives erythrocytes increased surface area necessary for carrying oxygen and carbon dioxide. The shape of RBCs also forms rouleaux, or stacks, that allow them to flow through narrow capillaries. In addition, red blood cells are quite flexible, which also allows for a quick passage through narrow capillaries.

C. Red blood cells do not contain cellular organelles, including nuclei. Therefore, RBCs have a short lifespan of approximately 120 days. They obtain energy from anaerobic metabolism of glucose in the surrounding plasma, which ensures that they will not use the oxygen being transported for their own purposes.

IV. Hemoglobin

Hemoglobin is the gas-carrying molecule in red blood cells and makes up 95 percent of the proteins within erythrocytes. Each hemoglobin molecule contains two alpha chains and two beta chains with a heme group that carries an iron ion, to which oxygen molecules attach. When oxygen binds to hemoglobin, it is known as oxyhemoglobin. The blood in a fetus contains fetal hemoglobin that more readily binds oxygen. The fetal hemoglobin begins to convert to regular adult hemoglobin just before birth. Hemoglobin can also bind carbon dioxide, which is known as carbaminohemoglobin. If the number of RBCs drops below normal, less oxygen is able to reach body tissues, which results in a condition known as anemia.

V. Blood Types

Antigens are molecules that stimulate the immune system to respond. Some antigens are normal in a particular individual’s body and do not trigger an immune response. Surface antigens, found on the cell membrane, in RBCs are responsible for determining one’s blood type. Three of these RBC surface antigens, called agglutinogens, give humans a specific blood type: A, B, and Rh (D). If blood types are crossed, clotting within the blood can occur, blocking vessels and damaging tissue.

A. Type A blood contains only antigen A and makes up 40 percent of the population.

B. Type B blood contains only antigen B and makes up 10 percent of the population.

C. Type AB blood contains both A and B antigens and makes up only 4 percent of the population. People with AB blood are universal recipients.

D. Type O blood contains neither A or B antigens and makes up the majority of the population at 46 percent. Type O blood is the universal donor.

E. Rh-positive blood contains the Rh surface antigen, while Rh-negative blood does not contain the Rh surface antigen.

Lecture 7
Blood

I. White Blood Cells

White blood cells, or leukocytes, fight off pathogens, rid the blood of waste, and destroyed damaged cells. They are called white blood cells because they do not contain hemoglobin; however, they do contain cellular organelles. WBCs move in several ways. Some move in an ameoba-like method, some move through capillary walls, some move in response to a chemical stimulus, and some engulf pathogens by phagocytosis. There are five different types of leukocytes: neutrophils, eosinphils, basophils, monocytes, and lymphocytes.

A. Neutrophils make up the majority of WBCs in the blood. They move quickly and are the first to arrive at an injury site. When reaching a bacterial cell, the neutrophils engulf it by phagocytosis. The neutrophil kills the bacterium by a toxic chemical and then transfers the remains to a lysosome, which breaks down the bacterium with digestive enzymes. Neutrophils only live an average of ten hours, and after it has engulfed one to two dozen bacteria, it releases a chemical to attract other neutrophils.

B. Eosinophils make up only two to four percent of the white blood cells. They act by engulfing pathogens by phagocytosis that have already been covered with antibodies. Eosinophils act mostly in attacks against large parasites, such as parasitic worms. They also increase in number during an allergic reaction, and they release an anti-inflammatory enzyme at sites of injury.

C. Basophils are small and the most rare of the while blood cells. They travel through the capillary wall to an injury site where they release their granules that contain histamine and heparin. Basophils work with mast cells and increase inflammation.

D. Monocytes are large and aggressive phagocytic white blood cells. They circulate in the blood for approximately 24 hours and then enter body tissues as a macrophage that attacks large items. For items that are very large, monocytes will join together and form a phagocytic giant cell. As they fuse to form the giant cell, they release chemicals that attract other WBCs and fibroblasts, which form scar tissue.

E. Lymphocytes are white blood cells that continually circulate from the blood to peripheral tissues. There are three classes of lymphocytes. T cells are active in immunity against foreign cells and tissues. B cells produce antibodies by differentiating into plasma cells that synthesize antibodies. NK cells identify and attack foreign tissue and are important in cancer prevention.

II. White Blood Cell Count

As the body undergoes an infection, an injury, or an allergic reaction the number of white blood cells in the blood naturally changes. Leukopenia means that the number of white blood cells is inadequate. Leukocytosis is an increased amount of white blood cells that can be a result of an infection. In extreme leukocytosis, it can be a form of leukemia.

III. White Blood Cell Production

Stem cells, found within bone marrow, produce white blood cells. However, not all white blood cells are produced in the same way. Neutrophils, eosinophils, basophils, and monocytes are formed by progenitor cells. All of these cell types except monocytes proceed through a series of steps and complete development in the bone marrow. Monocytes begin to develop in the bone marrow, but then enter the bloodstream to finish maturation. Lymphocytes, produced by lymphoid stem cells, begin development in the bone marrow and then travel to lymphoid tissues such as the thymus, spleen, and lymph nodes, to finish development.

IV. Platelets

Platelets are cell fragments that are responsible for blood-clotting. Platelets circulate for 9-12 days and then are destroyed by phagocytes in the spleen. Platelets create blood clots by releasing chemicals that aid in clotting, by clumping together to form a platelet plug at the injury site, and by contracting after a clot has formed to decrease the size of the break in the vessel wall. Thrombocytopoiesis, platelet production, occurs in megakaryocytes in bone marrow. Megakaryocytes produce proteins, enzymes, and membranes and then begin releasing packets of cytoplasm within a membrane. These cytoplasm packets are platelets, and each megkaryocyte generally manufactures around 4000 platelets.

V. Hemostasis

Hemostasis is the process of preventing blood loss at an injury site and providing a framework for tissue repair.

A. In the vascular phase of hemostasis smooth muscles within the broken blood vessel contract to constrict blood flow at the injury site.

B. The platelet phase comes next, which is where the platelets began to gather and stick to the injury site. The platelets also stick together and form a platelet plug to close off the injury site. Platelet become activated, which means they change shape and begin releasing various chemicals.

C. The coagulation phase begins after the platelet phase and involves circulating fibrinogen which converts to the protein fibrin. This network of fibrin grows to cover the platelet plug and attracts additional blood cells and platelets to form a blood clot.

D. After the blood clot has formed, the actin and myosin filaments within the platelets contract, reducing and stabilizing the injury site.

E. As tissue repair takes place, fibrinolysis begins. Fibrinolysis occurs as the enzyme plasmin is released and begins to dissolve the blood clot at the injury site.

Lecture 8
The Heart

I. General Characteristics of the Cardiovascular System

The primary organ of the cardiovascular system is the heart, which is responsible for circulating blood through the body. Within the cardiovascular system, there are pulmonary vessels that carry blood to and from the lungs. Systemic vessels carry blood between the lungs and body tissues. Arteries carry blood away from the heart, and veins carry blood to the heart. Capillaries are narrow vessels whose thin walls allow for the transmission of gases and nutrients to body tissues.

II. Anatomy of the Heart

The heart, which is surrounded by the pericardial cavity, lies posterior to the sternum and slightly left of the body's midline. There are four chambers in the heart: the left atrium, the right atrium, the left ventricle, and the right ventricle. The pericardial cavity contains the heart, thymus, esophagus, and trachea. The pericardium is the membrane lining the pericardial cavity.

A. The right atrium is the chamber located in the top right portion of the heart. The right atrium receives blood from systemic vessels called the superior vena cava and the inferior vena cava. The superior vena cava retrieves blood from the head, neck, upper limbs, and chest and delivers it to the right atrium. The inferior vena cava brings blood from the trunk and lower limbs. In the human embryo there is an opening in the wall between the right and left atria called the foramen ovale. This opening allows blood to flow through while the lungs are developing. Shortly after birth, the foramen ovale closes leaving a depression called the fossa ovalis.

B. Blood flows to the right ventricle once it leaves the right atrium. The blood travels through the right atrioventricular valve, or tricuspid valve, which is an opening that has three cusps that close to prevent backflow when the right ventricle contracts. The blood then passes through the right ventricle through the pulmonary semilunar valve, which also contains three cusps. The blood then travels through all the capillaries of the lungs, where gas exchange takes place.

C. The left atrium collects the bloods after it has traveled through the lungs. The blood then travels through the left atrioventricular valve, or bicuspid valve, into the left ventricle. The left atrioventricular valve contains only two cusps, unlike the tricuspid valve in the right atrium.

D. Although the left ventricle holds the same volume of blood as the right ventricle, it is larger because it is made of much thicker and more muscular walls. This allows it to have enough pressure to pump the blood to the systemic circuit. Blood leaves the left ventricle via the aortic semilunar valve and enters the ascending aorta. The blood then flows through the aortic arch and into the descending aorta before taking oxygen to the rest of the body tissues.

E. The heart wall consists of three main layers. The outer layer is known as the epicardium. Connective tissue holds the epicardium to the myocardium. The myocardium contains the heart muscle that makes up the atria and ventricles. This heart muscle tissue is made up of intercalated discs that transmit the action potentials for contraction. The endocardium is the inner surface of the heart.

IV. The Heartbeat

The heartbeat occurs as the four chambers of the heart contract in coordinated manner. Certain cells within the heart are responsible for making sure that the heart muscles contract in a specific sequence.

A. Contractile cells produce the contractions that create blood flow. These cells make up 99 percent of the cells within the walls of the atria and ventricles. Like skeletal muscles, the contractile cells are activated by action potentials that release calcium ions, which initiate the contraction of myofibrils. However, there are differences in the contraction of skeletal muscles and cardiac muscles. The action potential in cardiac muscle generally lasts 250-300 msec, whereas in skeletal muscle the action potential lasts only 7.5 msec. The resting potential of skeletal muscle is –85 mV, and in ventricular muscle it is –90 mV. In atrial muscle the resting potential is –80 mV.

B. The conducting system is a network of cells that initiate contractions in cardiac muscle, because cardiac muscles contract without neural or hormonal stimulation. This is called automaticity. The cells in the conducting system provide the electrical stimuli for contraction.

V. The Cardiac Cycle

The cardiac cycle is the period between heartbeats and consists of alternating contraction and relaxation. Each chamber has two phases within the cardiac cycle. One phase is the systole phase, in which the chamber pushes blood into another chamber or into an artery. The other phase is the diastole phase, where the chamber is relaxing and filling with blood for the next contraction.

Lecture 9
Circulation

I. General Anatomy of Blood Vessels

The walls of arteries and veins are made up of three layers. The innermost layer is the tunica interna, which is made up of an endothelial lining and connective tissue. In arteries, the tunica interna contains the internal elastic membrane, which is a thick layer of elastic fibers. The tunica media is the middle layer, which contains smooth muscle tissue. The tunica externa is a layer of connective tissue on the outside of the tunica media.

II. The Differences between Veins and Arteries

Although the basic structure between veins and arteries is similar, there are some differences between the two types of vessels.

A. Arteries carry blood away from the heart, and veins carry blood to the heart.

B. The walls of arteries are thicker than veins because the tunica media contains more smooth muscle.

C. In a cross-section arteries retain their circular shape because of elastic fibers, and veins tend to collapse in a cross-section.

D. The endothelial lining in an artery collapses into folds when the smooth muscle contracts, and the lining of veins does not do this.

E. Arteries usually retain their shape, while veins sometimes collapse.

F. Veins are not as resilient to distortion as are arteries.

G. Veins contain valves that prevent backflow. Arteries do not have valves.

III. Arteries

Arteries have thick, muscular walls that give them the ability to change the diameter of the vessel and the ability to tolerate the pressure given by ventricular contractions. The ability to contract is known as contractility. The sympathetic nervous system stimulates arterial walls to contract. When arteries constrict it is called vasoconstriction, and relaxation of the arterial walls is called vasodilation.

A. Elastic arteries are large, resilient arteries that are up to 2.5 cm in diameter. The pulmonary and aortic trunks are examples of elastic arteries. The tunica media in elastic arteries contain more elastic fibers than smooth muscle. The increased elasticity allows the arteries to absorb the varying pressures coming from the cardiac cycle. Elastic arteries help to smooth the oscillations in pressure coming out of the heart, so that it maintains an even flow in the systemic system.

B. Muscular arteries are approximately 0.4 cm in diameter, and they contain more smooth muscle than elastic fibers in the tunica media. Examples of muscular arteries include the carotid, brachial, and femoral arteries.

C. Arterioles only have a diameter of 30 μm and only contain one to two layers of smooth muscle in the tunica media. When arterioles vasoconstrict as a result of the nervous system or endocrine system, it creates resistance. Because of this resistance, they are also called resistance vessels.

IV. Disorders of the Arteries

A. Arteriosclerosis occurs when the walls of arteries thicken and toughen. Arteriosclerosis causes coronary artery disease (CAD) and accounts for almost fifty percent of deaths in the United States. There are two types of arteriosclerosis.

1. Focal calcification occurs when calcium salts are deposited in degenerated tunica media tissue. This usually affects the limbs and genital areas and is sometimes a side effect of diabetes mellitus.

2. Atherosclerosis is the thickening of arterial walls by lipid deposition. A high cholesterol diet can cause atherosclerosis.

B. Aneurysms occur as bulges form in a weakened area of an arterial wall. Over time, this weakened area bursts, similar to a blowout on a tire. They are usually a result of arteriosclerosis, high blood pressure, or Marfan's Syndrome. Aneurysms that occur in the brain or aorta are often fatal.

V. Capillaries

Blood travels through the arterial system to the capillaries. Capillaries are very thin vessels that allow the diffusion of gases, nutrients, and other materials. Capillaries do not have a tunica media or tunica externa, instead their walls consist of endothelial tissue within a basement membrane. The diameter of a capillary is almost the size of a single red blood cell (8 μm). Continuous capillaries and fenestrated capillaries make up the two major classes of capillaries.

A. Continuous capillaries supply most of the body with the materials it needs. These capillaries have a complete endothelial lining, and allow the diffusion of water, small solutes, and lipid-soluble materials. Continuous capillaries are not found in cartilage and epithelia tissue.

B. Fenestrated capillaries contain pores in the endothelial lining that allow the quick diffusion of water and larger solute molecules. Fenestrated capillaries are found in organs such as the hypothalamus, pituitary gland, pineal gland, and thyroid gland. Sinusoids are irregular and flattened fenestrated capillaries that have gaps between the endothelial cells and may be without a complete basement membrane. This allows the free exchange of water and materials.

VI. Veins

Veins are responsible for bringing all blood from bodily tissues back to the heart. The walls of veins are smaller than arteries, because there is less pressure in the blood flowing through them. However, veins are generally larger in diameter than arteries, and they are categorized by their size.

A. Venules are the smallest veins and are generally around 20 μm in diameter. They are responsible for collecting blood from the capillaries.

B. Medium-sized veins range from 2 to 9 mm in diameter and have a few smooth muscles in the tunica media. Their tunical externa is the thickest layer and contains bundles of elastic and collagen fibers.

C. Larges veins contain all three layers, and examples include the superior and inferior venae cavae.

VII. Venous Valves

Because blood pressure drops tremendously as blood flows through the systemic system, the flow cannot overcome gravity as it reaches the venules and medium-sized veins. Therefore, veins contain valves to prevent the backflow of blood toward the capillaries. When valves are functioning properly, all movements and contractions within skeletal muscles will push blood toward the heart. If venous walls weaken or become distorted, the valves may not work properly, and blood will begin to pool causing varicose veins.

Lecture 10
Cardiovascular Physiology

I. Blood Flow

Blood flow through the blood vessels depends on the pressure, resistance, viscosity, and turbulence found throughout the circulatory system.

A. The hydrostatic pressure found in the vessels allows for the blood to reach all body tissues. Blood pressure refers to the pressure in the arteries. Capillary pressure denotes the pressure within the capillaries, and venous pressure is the pressure within the veins.

B. Resistance is the force that acts against blood flow in the vessels. Most of this resistance comes from the friction created in the vessels as the blood cells pass through. This vascular resistance is dependent on vessel length and diameter.

C. Viscosity refers to the resistance created by the molecules within the liquid, or in this case, blood. Water has a low viscosity, while thicker liquids have a high viscosity. Blood viscosity can be altered by conditions like anemia.

D. Turbulence occurs when resistance is created by irregularities in the heart or vessels. These irregularities add resistance and slow blood flow. Deformed heart valves (murmurs) or damaged vessel walls create turbulence.

II. Capillary Exchange

Because the walls of capillaries are very thin, movement of molecules in and out of capillaries occurs in three ways.

A. Diffusion takes place as small molecules move across the capillary wall from an area of high concentration to and area of low concentration. Ions, amino acids, water, and small organic molecules are a few substances that move by diffusion.

B. Filtration occurs as the blood pressure forces small molecules across capillary walls. All larger molecules are filtered.

C. Reabsorption occurs as water moves by osmosis across capillary walls. This means that water will move to an area with higher solute concentration to try to reach equilibrium.

III. Venous Return

Although the pressure in the veins is lower than the pressure in the arteries, the venous pressure must overcome gravity and other factors in order to reach the right atrium. The efficiency of venous return is dependent upon both muscular compression and the respiratory pump.

A. Muscular contractions near veins help in venous return. As skeletal muscles contract, blood is pushed back to the heart.

B. The respiratory pump helps to pull blood into the right atrium from the venous system as air pressure in the pleural cavity changes during inhalation and exhalation.

IV. Cardiovascular Regulation

The cardiovascular system and blood flow must be regulated accurately in order for bodily tissues to receive necessary elements. The cardiovascular system is regulated by local factors, neural mechanisms, and the endocrine system.

A. Local factors act to regulate blood flow in the immediate tissue. Chemical changes in the interstitial fluid cause an alteration in the capillaries that will alter blood flow.

B. The nervous system controls blood flow from the cardiac center and vasomotor center of the medulla oblongata. The cardiac center can increase or decrease cardiac output by either the sympathetic or parasympathetic nervous systems, respectively. The vasomotor system can control either vasodilation or vasoconstriction.

V. Baroreceptors

Baroreceptors are found in the carotid and aortic sinuses and in the wall of the right atrium. These receptors are triggered by changes in blood pressure. As pressures change within the areas where baroreceptors are located, the baroreceptors are activated. When blood pressure rises, the baroreceptors trigger the cardiovascular center to decrease cardiac output. If blood pressure drops, the baroreceptors cause the sympathetic nervous system to increase cardiac output.

VI. Chemoreceptors

Chemoreceptors react when there are changes in the carbon dioxide, oxygen, or pH levels in the blood or cerebrospinal fluid. When a fluctuation in the chemicals occurs, the chemoreceptors activate the cardiovascular centers in the brain.

VII. Endocrine Control of Circulation

Several hormones can influence circulation. Both norepinephrine and epinephrine can stimulate cardiac output. ADH stimulates vasocontriction to elevate blood pressure. Angiotensin II triggers vasoconstriction, and it also activates the release of ADH from the pituitary and increases thirst. Erythropoietin, released from the kidneys, activates red blood cell production, which increases blood volume and oxygen-carrying capability. Atrial Natriuretic Peptide (ANP), produced in the right atrium, causes a decrease in blood volume and blood pressure.

VIII. Exercise and the Cardiovascular System

Exercise causes changes in the cardiovascular system. During exercise vasodilation occurs, venous return increases, and cardiac output increases. Performing consistent exercise over time can cause some very beneficial changes in the cardiovascular system. Athletes have a larger stroke volume and slower heart rate, meaning that the heart is working more efficiently.

IX. Shock

Shock is a result of low cardiac output and low blood pressure. There are various causes of shock, including significant blood loss or damage to the heart. There are three stages of shock: compensated, progressive, and irreversible.

A. In the compensated stage the body is able to tolerate the reduced blood flow, and bodily organs are still functioning with the aid of homeostatic mechanisms.

B. During the progressive stage, the body is unable to tolerate the reduced cardiac output. The brain begins to suffer from blood loss, and peripheral tissue function is at a minimum. Immediate treatment is required or death will occur.

C. In the irreversible stage, vital organs are unable to sustain life, and death often occurs even with medical treatment. Blood pressure is very low and capillaries collapse, preventing blood flow to vital organs.

Lecture 11
The Lymphatic System and Nonspecific Immunity

I. General Characteristics of the Lymphatic System

The lymphatic system provides an immune response against viruses, bacteria, cancer cells, and foreign proteins. The lymphatic system produces and distributes lymphocytes, which are cells that provide immune response. The lymph vessels also aid the capillaries by carrying fluids and solutes from peripheral tissues. The lymph system also carries nutrients, hormones, and waste products from peripheral tissues to the blood. The lymphatic system is made up of lymphoid organs, lymphatic vessels, and lymph.

II. Lymphatic Vessels

Lymphatic vessels, or lymphatics, carry material retrieved in the body tissues to the veins.

A. Lymphatic capillaries are similar to blood capillaries, except for a few differences. Lymphatic capillaries begin as blind pockets, are larger in diameter, and have thinner walls. There are lymphatic capillaries in almost every organ in the body.

B. Lymphatic vessels receive fluid from the lymphatic capillaries and are similar to blood vessels. Lymphatic vessels have bulging valves that prevent backflow and give the vessel a beaded appearance.

III. Lymphocytes

Lymphocytes make up approximately 20-30 percent of white blood cells, which add up to about one kilogram combined weight.

A. T cells make up about 80 percent of circulating lymphocytes. Cytotoxic T cells attack foreign cells or virus-infected cells, and are the primary cells involved in cellular immunity. Helper T cells activate T cells and B cells. Suppressor T cells inhibit action by T cells and B cells.

B. B cells differentiate into plasma cells that produce antibodies. Antibodies attach to antigens, which eventually leads to their destruction called antibody-mediated immunity.

C. NK cells, or large granular lymphocytes, police body tissues to attack foreign cells, cancer cells, and virus-infected cells. This is known as immunological surveillance.

IV. Lymphocyte Production

Lymphocyte production, or lymphopoiesis, is a joint effort of the bone marrow, the thymus, and the lymphoid tissues. Bone marrow is responsible for making lymphocyte stem cells. The stem cells that produce B cells and NK cells remain in the bone marrow to work with stromal cells in order to develop. Another group of stem cells leaves the bone marrow and travels to the thymus to produce T cells. Thymosins are thymus hormones that stimulate the production of several different kinds of T cells. T cells and B cells are able to divide and produce daughter cells once they leave the area where they were produced.

V. Lymphoid Tissues

Lymphoid tissue is an area of connective tissue that contains a high number of lymphocytes. Lymphoid nodules have a highly dense area of lymphocytes in loose connective tissue. These nodules are found in the respiratory, digestive, and urinary systems. They also have a germinal center that contains dividing lymphocytes. Tonsils are large lymphoid nodules.

VI. Lymphoid Organs

Lymphoid organs are separated from surrounding tissue in a capsule of fibrous connective tissue. The lymph nodes, the thymus, and the spleen are all lymphoid organs.

A. Lymph nodes are kidney bean shaped organs that remove pathogens from lymph before it reaches the bloodstream. Lymph nodes are also stimulated by nearby infections. This may result in "swollen glands" as an increased number of lymphocytes and phagocytes respond within the lymph node.

B. The thymus is the organ that produces the T cells, and is located posterior to the sternum. It increases in size until it reaches its maximum size at puberty. Afterwards, it begins to decrease as it becomes more fibrous.

C. The spleen is the largest lymph organ. It functions to remove abnormal material from the blood, store iron from recycled RBCs, and initiate the action of B cells and T cells.

VII. Nonspecific Immune Response

The human body has certain immune responses that are activated no matter what pathogen or hazard may be causing harm.

A. Physical barriers, including skin and hair, make it difficult for pathogens to enter body tissues.

B. Phagocytes engulf cell debris and pathogens once they enter the body tissues.

C. In immunological surveillance, NK cells destroy abnormal cells.

D. Interferons defend against viruses.

E. Complement is a system of proteins that aid antibodies in pathogen destruction.

F. Inflammation occurs in injured tissue to prevent the spread of injury or infection.

G. Fever accelerates metabolism to aid in defense.

Lecture 12
Specific Immune Response

I. Specific Immune Response

Specific immune response, when specific pathogens are attacked, occurs as a coordinated effort of T cells and B cells. T cells attack pathogens within living cells. B cells form antibodies to attack pathogens in body fluids.

II. Types of Immunity

Several types of immunity occur in the human body.

A. Innate immunity is genetically determined. For instance, humans are not likely to get diseases that lizards are prone to.

B. Acquired immunity is not innate and is developed after being exposed to specific antigens. There are several types of acquired immunity.

1. Active immunity occurs when the body is exposed to antigens either by natural means or induced means. This exposure stimulates the immune system to create antibodies. An immunization shot is an example of induced active immunity.

2. Passive immunity occurs when antibodies are given to a person to fight a specific pathogen. This can occur naturally between a mother through the placenta or breast milk. In induced passive immunity, the antibodies are given to fight infection or prevent disease.

III. Properties of Immunity

When immune response is specific resistance, it has certain characteristic properties.

A. Specificity occurs when lymphocytes produce antibodies to attack a certain antigen.

B. Versatility means that lymphocytes are able to attack thousands of antigens by producing a variety of antibodies.

C. Memory enables the immune system to counteract stronger the second time it identifies a specific antigen.

D. Tolerance exists when the body does not respond to a particular antigen.

IV. T Cell Activation

Once T cells are exposed to an antigen, they begin to move into peripheral tissues to directly attack the antigen. T cells are activated once they recognize an antigen attached to a protein in the cell membrane called the major histocompatibility complex (MHC). There are two types of MHC proteins: Class I and Class II.

A. Class I MHC proteins are located in the cell membranes of all cells that contain a nucleus. If a T cell finds a MHC protein-antigen complex in the membrane, it will become activated.

B. Class II MHC proteins are found only in specialized antigen-presenting cells (APCs). APCs are located in various tissues, and the Class II MHC proteins are only present in the membrane when the cell is infected by an antigen. T cells will become activated when they come in contact with APCs in a cell's membrane.

V. Cluster Designation (CD) Markers

T cell membranes contain CD markers that determine whether the T cell will respond to a Class I MHC or a Class II MHC. CD8 markers, found on cytotoxic and supressor T cells, are activated by Class I MHC proteins. CD4 markers, found on helper T cells, are activated by Class II MHC proteins.

VI. Steps of T Cell Immunity

A. The T cell recognizes the antigen.

B. Once the T cell has recognized an antigen, it must bind to a stimulating cell. This process called costimulation ensures that the T cell will not begin attacking healthy cells, if the T cell did not recognize the antigen correctly.

C. Cytotoxic T cells form once the CD8 T cells are activated. When cytotoxic T cells encounter cells containing the target antigen, they destroy that cell.

D. Memory T cells also form when the CD8 T cells are activated. Memory T cells remain in reserve, and if the antigen reappears, the memory T cells differentiate into cytotoxic T cells and quickly attack the antigen.

E. Supressor T cells inhibit the effect of other T cells and B cells. They act after the initial immune response to limit the reaction of the immune system.

F. CD4 T cells produce helper T cells and memory T cells. Helper T cells activate non-specific immunity responses and B cell production.

VII. Antibody-Mediated Immunity

B cells produce antibodies in order to fight off antigens.

A. B cells become sensitized when the antibodies they carry in the cell membrane bind to an antigen.

B. As a safety precaution, a B cell is not fully activated until it is stimulated by a helper T cell.

C. Activated B cells then begin producing plasma cells and memory B cells.

D. The plasma cells produce antibodies and release them into the interstitial fluid.

E. Memory B cells wait as a reserve in case the same antigen enters tissues again in the future.

VIII. Antibody Structure

Antibodies are made up of a pair of light and a pair of heavy polypeptide chains, which contain constant and variable segments. The constant segments of the heavy chains determine which class of immunoglobulins the antibody belongs to. The constant segments also determine how the antibody is secreted and distributed in the body. The constant segments of the heavy chains bind to the constant segments of the light chains. The variable segments of the light and heavy chains determine the antibody's specificity and provide a binding site for the antigen. Antibodies bind to antigens at regions called antigenic determinant sites to form the antigen-antibody complex.

IX. Antibody Action

Once the antibody-antigen complex forms, antibodies eliminate antigens in several ways.

A. Neutralization means that the antibody prevents the antigen from attaching to its target cell in the body.

B. Agglutination and precipitation refer to an antibody that forms a three-dimensional complex. This occurs when one antibody binds to more than one antigen creating an immune complex. In precipitation the complex is too large to stay in solution, and agglutination occurs when the antigen is on the surface of a cell or virus.

C. Some antibodies cause the antigen to change shape, which allow complement proteins to bind, destroying the antigen.

D. When antibodies cover an antigen, it attracts the various phagocytes that engulf and destroy the antigen.

E. Osponization refers to the fact that phagocytes are able to destroy antigens when antibodies are covering them.

F. Antibodies can enhance inflammation.

G. Antibodies can also prevent infection by coating epithelia and preventing antigens from entering the body.

Lecture 13
General Anatomy of the Respiratory System

I. Functions of the Respiratory System

The respiratory system provides a way for the body tissues to receive oxygen needed for metabolism. The lungs provide an area for gas exchange. The respiratory system is also responsible for the ability of humans to speak and produce sounds, and for providing olfactory sensations through the nasal passages. The capillaries of the lungs also indirectly assist in the regulation of blood volume and pressure by converting angiotension I to angiotension II.

II. The Upper Respiratory System

The upper respiratory system is made up of the nose, nasal cavity, paranasal sinuses, and pharynx. The job of the upper respiratory system is to warm and moisten incoming air, which protects the lower respiratory system.

A. The nose, which opens into the nasal cavity, is the primary pathway for incoming air. The vestibule inside the nose contains hair that traps debris to prevent it from entering the nasal cavity. Mucus from the paranasal sinuses along with moisture from the tear ducts, keep the nasal cavity clean.

B. As air passes through the nasal passageways to the lungs, the air is warmed close to body temperature and is filled with water vapor. This protects the delicate tissues of the lungs from getting chilled and dried out. Breathing through the mouth eliminates a great deal of this filtration. By exhaling, warmth and moisture are conserved in the nasal passageway.

C. Used by both the respiratory and digestive systems, the pharynx is a chamber that begins at the internal nares and ends at the beginning of the larynx. Divisions of the pharynx include the nasopharynx, the oropharynx, and the laryngopharynx.

III. The Larynx

As air leaves the pharynx, it passes through the glottis and enters the larynx. The larynx houses the vocal cords and is responsible for the production of vocal sounds.

A. The walls of the larynx are made of cartilage, which are supported by ligaments and skeletal muscles. The thyroid cartilage protrudes anteriorly to create the Adam's apple. The epiglottis is a segment of elastic cartilage that folds back over the glottis during swallowing to prevent food or liquid from entering the respiratory passageway.

B. A set of ligaments supports the cartilages of the larynx. These ligaments include the ventricular and vocal ligaments. The ventricular ligaments provide protection for the vocal ligaments and are called the false vocal cords because they do not directly create sound. The vocal ligaments are elastic bands known as vocal cords, which produce sound.

IV. The Trachea

The trachea, also known as the windpipe, is a tube approximately 2.5cm in diameter that provides an air passageway from the larynx to the primary bronchi. The trachea is lined with mucosa similar to that of the nasal cavity. Tracheal cartilages also surround the trachea to protect the trachea and prevent it from collapsing.

V. The Primary Bronchi

The trachea divides and forms the left and right primary bronchi, which lead into the left and right lung perspectively. The right primary bronchus joins the lung at a steeper angle and is larger in diameter than the left primary bronchus. Therefore, foreign objects are usually lodged in the right bronchus.

Lecture 14
The Lungs

I. General Anatomy of the Lungs

Both the left and right lung are divided into lobes. The right lung is divided into three lobes, while the left is only divided into two lobes. While the left lung is narrower than the right lung to allow room for the heart, the left lung is slightly longer than the right lung. Within the lungs, the primary bronchi divide into smaller bronchi and bronchioles. The bronchioles finally lead to small sacs called alveoli, where gas exchange takes place.

II. The Bronchi

The primary bronchi, located outside the lungs, divide into secondary and tertiary bronchi, which are located within the lungs. This network of bronchi is called the bronchial tree. The primary bronchi contain cartilage rings, similar to the trachea. As the bronchi divide, the number of cartilage rings decreases, while smooth muscle begins to increase. The smooth muscle creates tension in the bronchi, therefore influencing air resistance.

III. The Bronchioles

The bronchioles form as the bronchi continue to divide. There are no cartilaginous rings in the bronchioles, and smooth muscle is responsible for controlling air flow. The sympathetic nervous system causes an increase in bronchiole diameter, while the parasympathetic nervous system causes a decrease in diameter. Bronchoconstriction, a decrease in diameter, can be a result of an allergic reaction or asthma.

IV. Alveoli

Bronchioles lead to the alveoli, which are small sacs where gas exchange takes place. The alveoli are surrounded by capillaries that take oxygen into the bloodstream. The gas exchange takes place across the respiratory membrane. This membrane may be as little as 0.1 μm, which allows for very rapid gas exchange.

V. Tuberculosis

Tuberculosis is a disease caused by an infection of *Mycobacterium tuberculosis* in the lungs. Tuberculosis is an infectious disease, in which the symptoms include fever, coughing, chest pain, and weight loss.

VI. Pneumonia

Pneumonia is a condition that results from an invasion of a pathogen that causes inflammation in the lobules of the lungs. This inflammation causes fluid to build up in the alveoli, leading to breathing difficulty.

VII. Birth and the Respiratory System

The respiratory system of a fetus is quite different from that of a newborn infant. Before birth the lungs of a fetus are completely filled with fluid. After birth the infant's first breath, caused from contractions of the diaphragm and intercostal muscles, forces air into the fluid-filled lungs. This first breath also begins pulmonary blood flow and closes the foramen ovale in the heart. The lungs empty of fluid and the alveoli inflate as the infant exhales in the next few breaths.

Lecture 15
Process of Respiration

I. Basics of Respiration

Respiration, which is the exchange of gases between cells and the outside environment, involves both internal and external respiration. External respiration involves the movement of oxygen from the outside environment, to the lungs, and then into the bloodstream. Internal respiration takes place as the cells within the body take in oxygen and release carbon dioxide. Hypoxia is a condition resulting from low oxygen levels in body tissues. Anoxia results when the oxygen supply stops, in which case, cell death occurs quickly.

II. Pulmonary Ventilation

Pulmonary ventilation, or the movement of air into and out of the body, is governed by a variety of factors.

A. Boyle's Law explains how air enters and leaves the lungs during inhalation and exhalation. During inhalation, the diaphragm contracts causing the thoracic cavity to expand, which increases the volume within the lungs. Air then flows into the lungs because the air pressure within the lungs is lower than the air pressure in the outside environment. During exhalation, the diaphragm relaxes and the pressure within the lungs is greater than the outside environment, so air flows out of the lungs. The compliance of the lungs, or the ability to expand, also influences the amount of airflow into and out of the lungs.

B. The respiratory cycle is one breath, inhalation and exhalation. Tidal volume refers to the volume of air that passes through the lungs in a respiratory cycle.

C. During inhalation and exhalation, muscles are responsible for changing the volume of the lungs. While inhaling, the diaphragm and external intercostal muscles expand the lungs. If breathing is deep, various other accessory muscles can also aid in inhalation. Depending on respiratory activity, exhalation can involve the internal intercostals, the transversus thoracis, and the abdominal muscles.

D. In eupnea, or quiet breathing, exhalation is a passive process. When breathing deep, the diaphragm is mainly responsible for increasing volume in the lungs. When breathing is shallow, the intercostal muscles are primarily responsible for increasing volume in the lungs.

E. In hypernea, or forced breathing, more muscles are involved in both inhalation and exhalation. During inhalation, the accessory muscles act to help increase the volume in the lungs. Exhalation becomes an active process, the internal intercostals and the abdominal muscles push air out of the lungs.

F. Respiratory rate tells the number of breaths taken in a minute.

G. The respiratory rate multiplied by the tidal volume give us the amount of air taken into the lungs per minute, or the respiratory minute volume. The amount of air that actually reaches the alveoli and takes place in gas exchange is less than the respiratory minute volume, because some air remains in the bronchioles of the lungs and never reaches the alveoli. When necessary, for example during exercise, the respiratory minute volume can increase by either increasing the tidal volume or the respiratory rate.

III. Pulmonary Performance

The efficiency of an individual's lungs can be determined by measuring various volumes and capacities of air that enter and exit the lungs. These measurements help to diagnose problems within the respiratory system.

A. Resting tidal volume is the volume of air that passes into and out of the lungs in a single quiet breath.

B. The expiratory reserve volume is the amount of air that can be expelled after a quiet respiratory cycle.

C. Residual volume is the amount of air that remains after a voluntary maximum exhalation.

D. The inspiratory reserve volume is the amount of air that can be taken into lungs over the tidal volume.

E. Inspiratory capacity = tidal volume + inspiratory reserve volume

F. Functional residual capacity = expiratory reserve volume + residual volume

G. Vital capacity = expiratory reserve volume + tidal volume + inspiratory reserve

H. Total lung capacity = vital capacity + residual volume

IV. Hemoglobin and Oxygen Transport

Only 0.3 percent of oxygen molecules are carried in solution in blood plasma. The rest of the oxygen molecules are carried on the hemoglobin molecules of the red blood cells. Each red blood cell contains approximately 280 million hemoglobin molecules, and each hemoglobin molecule can carry four molecules of oxygen. The amount of oxygen bound to the hemoglobin determines the hemoglobin saturation. The degree of oxygen-hemoglobin saturation depends on the partial pressure of oxygen. If the partial pressure of oxygen increases, then hemoglobin begins storing oxygen. If the partial pressure of oxygen decreases, then hemoglobin releases oxygen.

V. Carbon Dioxide Transport

The transport of carbon dioxide in the blood is a reversible reaction just as oxygen transport is a reversible reaction. Carbon dioxide is produced by cellular respiration within cells. Once the molecule of carbon dioxide enters the bloodstream, it can either be changed to carbonic acid, be bound to a part of the hemoglobin molecule, or be dissolved in the plasma.

VI. Respiratory Control

Control mechanisms for respiration can be voluntary or involuntary. Two respiratory centers in the medulla oblongata control the rate of respiration. These centers can then be altered voluntarily by the cerebral cortex. The two respiratory centers of the pons control respiratory output, which can also be altered by the cerebral cortex. Various sensory receptors also trigger varied respiratory response.

Lecture 16
The Digestive System

I. Digestive Functions

We spend hours a day filling and emptying our digestive system, which provides several functions for our body.

A. Ingestion is the conscious process of entering materials into the digestive system via the mouth.

B. Physical manipulation is the active process of distorting materials, usually with the teeth and tongue, to make it ready to proceed to the rest of the digestive system.

C. Digestion is the chemical breakdown of food into energy.

D. Secretion of water, acids, enzymes, and other compounds, occurs through the epithelium of the digestive track and glandular organs.

E. Absorption is the movement of materials across the digestive epithelium into the interstitial fluid of the digestive tract.

F. Excretion is the process of ridding the body of waste products.

II. Layers of the Digestive Tract

The digestive tract begins at the mouth and ends at the anus. Each individual organ along the digestive tract provides a specific function, but they also share certain characteristics. There are four major layers of tissue along the digestive tract.

A. The mucosa is the inner layer consisting of a mucous membrane. The innermost layer of the mucosa is the digestive epithelium, which is the site for absorption and mucus secretion. The lamina propria, which lies under the epithelium, is made of loose connective tissue. The lamina propria contains a layer of smooth muscle, elastic fibers, blood vessels, sensory nerve endings, and lymphatic vessels. The band of smooth muscle and elastic fibers is called the muscularis mucosae.

B. The submucosa is dense connective tissue that surrounds the muscularis mucosae. The submucosa contains nerves, blood vessels, and lymphatics.

C. The muscularis externa is the next layer, which is made of primarily smooth muscle cells. This layer is responsible for moving materials through the digestive tract.

D. The serosa is a serous membrane that covers the muscularis externa. However, there is no serosa in the oral cavity, pharynx, esophagus, or rectum.

III. Smooth Muscle Movement

The movement of material along the digestive tract occurs as contractions occur in visceral smooth muscle tissue. Pacesetter cells in the muscle tissue undergo spontaneous and rhythmic depolarization to initiate the contractions in the smooth muscle. Movement along the digestive tract occurs through peristalsis or segmentation.

A. Peristalsis occurs when the muscle of the muscularis externa pushes material from one segment of the digestive tract to another. In peristalsis, the circular muscles behind the material undergo waves of contractions to push it along the tract.

B. Segmentation generally occurs in the small and large intestines and is the process of mixing and churning materials with intestinal secretions. This type of movement does not move the material in any specific direction.

IV. Regulation of Digestion

Neural, hormonal, and local mechanisms all regulate the digestive system.

A. The movement of material through the digestive system is primarily regulated by the nervous system. Sensory receptors in the walls of the digestive tract trigger motor neurons. Receptors can also trigger short reflexes and long reflexes.

B. The digestive tract also produces several hormones that influence and regulate the mechanisms of the digestive system.

C. When local messengers such as, prostaglandins and histamine, are released, they can also create a response in localized areas of the digestive system.

VI. The Peritoneum

Within the abdominopelvic cavity is the peritoneal cavity lined with a serous membrane. This cavity contains fluid that lubricates the surfaces of the peritoneum. The mesentaries within the peritoneal cavity attach to various digestive organs and keep them in the proper places. Peritonitis is inflammation of the peritoneal cavity.

VII. Oral Cavity

The digestive tract begins with the oral cavity. The oral cavity includes the mouth, teeth, tongue, and salivary glands. The oral cavity is responsible for the entry of food, mechanical processing, lubrication of food, and the beginning of food digestion.

A. The anatomy of the mouth includes the oral mucosa, which lines the entire buccal cavity, or oral cavity. The hard palate at the top of the mouth helps in the mechanical processing of food. The soft palate extends posterior from the hard palate and supports the uvula.

B. The tongue provides several functions of digestion. It aids in bringing food into the oral cavity, and it manipulates food once it is inside the mouth to make chewing easier. The tongue is also involved in mechanical processing of the food, and it secretes mucus and an enzyme, called *lingual lipase*. *Lingual lipase* begins the breakdown of lipids before the food is swallowed. Plus, the tongue has sensory receptors for taste.

C. There are three pair of salivary glands in the oral cavity that each produce slightly different saliva. The parotid salivary glands produce a thick, serous secretion containing *salivary amylase* that begins the breakdown of starches. The secretions from the sublingual salivary glands act as a buffer and lubricant. The submandibular salivary glands produce a mixture of buffers, glycoproteins, and *salivary amylase*. These secretions combine to form saliva that lubricates the mouth, along with lubricating and breaking down food.

D. The teeth are primarily responsible for the mechanical processing of food before it moves along the digestive tract. The adult tooth count is 32 with four types of teeth. Incisors are located at the front of the mouth and are useful for clipping and cutting. The cuspids, or canines, lie next to the incisors and are useful for tearing. The bicuspids have flattened tops and are useful for crushing and grinding. The molars lie at the back of the mouth and have flattened tops that crush and grind food.

Lecture 17
The Digestive System

I. The Pharynx

The pharynx can be divided into three sections, the nasopharynx, the oropharynx, and the laryngopharynx. The pharynx provides a passageway for food, liquids, and air from the oral cavity to the esophagus. The pharynx also contains muscles that aid in swallowing.

II. The Esophagus

The hollow tube of the esophagus provides a route for food and liquid from the pharynx to the stomach. As food and liquids travel to the stomach, they pass through an opening in the diaphragm called the esophageal hiatus. Although they are not definite muscle sphincters, circular muscle tissue in the upper portion of the esophagus prevents air flow into the stomach, while a similar circle of muscle prevents backflow of food and liquid at the lower end of the esophagus.

III. Swallowing

Swallowing involves the voluntary movement of food and liquids down the esophagus and the involuntary movement of saliva that collects in the oral cavity. There are three main phases of swallowing:

A. The buccal phase is the voluntary phase in which the ingested material, or bolus, is pressed against the hard palate by the tongue and then into the pharynx.

B. The pharyngeal phase involves motor commands from the medulla oblongata as receptors on the palatal arches and uvula are triggered. During this phase, the bolus enters the esophagus, during which time breathing stops.

C. The esophageal phase involves peristaltic muscle contractions that propel the bolus to the stomach.

IV. Anatomy of the Stomach

The stomach is a J-shaped organ that stores ingested food, mechanically and chemically breaks down food, and produces the intrinsic factor that is required for vitamin B12 absorption. The stomach is divided into four main regions.

A. The cardia, the smallest region, is located near the junction of the esophagus and stomach. It functions to coat the esophagus with mucous to protect it from stomach acids and enzymes.

B. The fundus lies superior to the stomach-esophagus junction, and it provides a contact point with the diaphragm.

C. The body is the main portion of the stomach where the mixing of ingested material and gastric secretions takes place. Gastric glands in the fundus and body secrete these acids and enzymes.

D. The pylorus is the J-shaped segment of the stomach. The pylorus is responsible for releasing chyme into the duodenum, and it also secretes mucus and digestive hormones, which stimulate gastric glands.

VI. Gastric Glands

Gastric glands are found in the fundus and body of the stomach inside depressions called gastric pits. Gastric glands contain two types of cells: parietal cells and chief cells.

A. The parietal cells secrete both intrinsic factor and hydrochloric acid. The acid that is produced creates a pH of 1.5-2.0 in the stomach. This acidity kills microorganisms and helps break down food.

B. The chief cells produce pepsinogen that is converted to the enzyme pepsin once it comes in contact with the acid created by the parietal cells.

VII. Pyloric Glands

The pyloric glands produce mucous and various hormones. G cells within the pylorus secrete gastrin. Gastrin activates the parietal and chief cells, and it stimulates contractions in the gastric wall. D cells in the pylorus secrete somatostatin that in turn inhibits gastrin.

VIII. Regulation of Digestion

Gastric secretion is controlled by the brain, reflexes in the stomach wall, and by hormones of the digestive tract. Gastric secretion is divided into three phases: the cephalic phase, the gastric phase, and the intestinal phase.

A. In the cephalic phase, the brain stimulates the stomach to secrete gastric juices whenever an individual smells, sees, tastes, or thinks about food.

B. In the gastric phase starts when food enters the stomach, which has already been stimulated by the cephalic stage. Neural stimuli during this phase activate the contractions of muscle in the stomach wall that help in mixing the undigested food and the gastric juices. The gastric phase can last for several hours.

C. In the intestinal phase, material from the stomach begins to enter the small intestine. After mixing has taken place for several hours, chyme begins to enter the small intestine. This phase is controlled both by the nervous sytem and by hormones.

Lecture 18
The Digestive System

I. Anatomy of the Small Intestine

The small intestine works in conjunction with the secretions from the pancreas, liver, and gall bladder to absorb nutrients from digested food. The small intestine is divided into three regions, the duodenum, the jejunum, and the ileum.

A. The duodenum is the region closest to the stomach. It mixes chyme from the stomach with secretions from the liver and pancreas.

B. The jejunum is the next region of the small intestine, and it is where most of the nutrient absorption takes place.

C. The ileum is the last and longest section of the small intestine. It ends with a sphincter that controls movement of material into the large intestine.

II. Structures of the Small Intestine

A. Plicae are folds in the lining of the small intestine that increase surface area to provide added absorption. Plicae are found mostly in the jejunum.

B. Intestinal villi in the mucosa of the small intestine also add surface area to increase absorption. Villi are found mainly in the jejunum, where most absorption takes place.

C. Intestinal crypts contain glands that produce brush border enzymes that aid in digestion and absorption. They also contain enteroendocrine glands that produce various other intestinal hormones.

D. Submucosal glands in the duodenum produce mucous, which protects the epithelium from the acidic chyme, and they urogastrone, a hormone that inhibits the production of gastric acid.

E. Lymphoid nodules are located in the ileum. Lymphocytes found here protect the small intestine from the bacteria found in the large intestine.

III. The Pancreas

The pancreas is both an endocrine and exocrine gland. As an endocrine gland, it produces both insulin and glucagon. As an exocrine gland, the pancreas secretes pancreatic juice, which cosists of enzymes and buffers, into the small intestine. The lining of the pancreas contains cells that secrete buffers into the duodenum. These cells are stimulated by secretin, a hormone produced in the duodenum. Acinar cells produce the pancreatic enzymes. These enzymes help break down the chyme within the small intestine, and their secretion is triggered by the cholecystokinin, another duodenal hormone.

IV. The Liver

The liver is a large organ that provides many different functions. These functions include, regulation of metabolism, regulation of blood cells, and production of bile.

A. The liver controls the composition of the blood, and therefore, it regulates the metabolism. After blood leaves the digestive system, it travels through the liver. The liver then extracts nutrients and toxins. The nutrients can be stored for later usage.

B. The liver regulates blood composition in many ways. It rids the body of old or damages RBCs, and it can trigger an immune response when an antigen is present. The liver also produces the proteins found in blood plasma. Hormones, antibodies, and toxins circulating in the blood are also removed by the liver.

C. Bile is also produced and secreted by the liver. Bile salts enter the duodenum and help in the break down and absorption of lipid molecules.

VI. The Gallbladder

The gallbladder, which is located next to the lobes of the liver, stores and modifies bile. If cholecystokinin does not stimulate the secretion of bile from the liver to the duodenum, the bile travels to the gallbladder and is stored for later use. While in the gallbladder, the bile becomes more concentrated as water is absorbed.

VII. The Large Intestine

The large intestine begins at the ileum of the small intestine. It curves around the small intestine and ends at the anus. The large intestine contains three main sections: the cecum, the colon, and the rectum. The large intestine provides the following functions.

A. It reabsorbs water and condenses material from the small intestine into feces.

B. It absorbs any nutrients that may have been created from the breakdown by bacteria. The bacteria in the colon release vitamin K, biotin, and vitamin B5 as they breakdown the material in the large intestine.

C. It stores the fecal material until it leaves the body. Neural stimuli created in response to activity in the stomach and small intestine trigger peristaltic contractions that force fecal material out of the rectum.

Lecture 19
The Urinary System and Kidney Function

I. Functions of the Urinary System

The main function of the urinary system is to eliminate waste from the body. The kidneys, ureters, urinary bladder, and the urethra all work to clean up the waste made by the cells in the body. The urinary system also provides more obscure functions.

A. It helps control blood volume and pressure by changing water volume in urine, by releasing erythropoietin and renin.

B. It helps control concentrations of ions in plasma.

C. It regulates the loss of hydrogen and bicarbonate ions to help stabilize blood pH.

D. It conserves nutrients and eliminates waste.

E. It helps the liver neutralize toxins.

II. Overview of Kidney Anatomy

The kidneys are the primary organs responsible for excretion. They clean the blood and produce urine. The kidneys lie on either side of the spinal column between vertebrae T12 and L3.

A. The renal capsule, made of collagen fibers, provides an outer covering for the kidney.

B. The adipose capsule, made of adipose tissue, surrounds the renal capsule.

C. The renal fascia is the outermost layer that connects the kidney to the surrounding structures. Collagen fibers from the renal capsule extend through the adipose tissue to the renal fascia, making a dense, fibrous layer.

D. The hilus is the indention made where the renal artery and renal vein enter the kidney.

E. The renal sinus is a cavity within the kidney.

F. The renal cortex is the outer layer of the kidney that connects with the renal capsule.

G. The renal medulla is the inner layer of the kidney and is made up of the renal pyramids and columns.

H. The renal lobe is made up of a renal pyramid, the corresponding columns, and the adjacent area of the renal cortex. Urine production occurs within the renal lobes.

III. The Nephron

The production of urine begins in the nephron. The renal cortex contains the microscopic nephrons, which consist of a renal corpuscle and a renal tubule.

A. The renal corpuscle is a cup-shaped structure that contains a network of capillaries called the glomerulus. Filtration occurs in the renal corpuscle. Blood enters the glomerulus and blood pressure forces fluid out of the capillaries, filtering the blood.

B. The region that covers the glomerular capillaries is called the Bowman's capsule.

C. The filtrate created by the renal corpuscle then enters the renal tubule system.

D. The filtrate first enters the proximal convolute tubule (PCT). The purpose of the PCT is to reabsorb nutrients, ions, and plasma proteins from the filtrate. Because of osmosis, water also joins these reabsorbed molecules in the interstitial fluid surrounding the renal tubule.

E. The filtrate, or tubular fluid, then travels along the loop of Henle. The loop contains both a descending limb and an ascending limb. The descending limb provides a function similar to that of the PCT.

F. The tubular fluid then travels through the distal convoluted tubule. In the DCT, ions, acids, and other substances, are secreted into the fluid. Selective reabsorption of ions and water also takes place. This helps to concentrate the tubular fluid.

G. The last section of the nephron is the collecting system. Connecting tubules from each nephron empty into a collecting duct. Collecting ducts empty into a papillary duct that empties into a minor calyx. The collecting system also controls the final concentration and volume of urine.

IV. Blood and Nerve Supply to the Kidneys

Approximately one-fourth of the cardiac output enters the kidneys via the renal arteries. The renal arteries divide and get smaller and smaller, until the blood passes through the glomerular capillaries. The blood then travels through the pertubular capillaries and the capillaries of the vasa recta. The pertubular capillaries supply the PCT and the DCT, and the vasa recta supplies the loop of Henle. Once the blood leaves the network of capillaries, it combines in a series of veins and leaves the kidneys via the renal veins. The urinary system is controlled by the renal nerves of the sympathetic nervous system.

Lecture 20
Renal Physiology

I. Composition of Urine

There are three main waste materials that the urinary system eliminates from the body. Each waste product is the result of cell metabolism.

A. Urea results from the breakdown of amino acids. The body produces more urea than any other waste product.

B. Creatinine is the waste product produced from the breakdown of creatine phosphate in skeletal muscles.

C. Uric acid is the waste created by the recycling of nitrogenous bases from RNA molecules.

II. Concentration of Urine

The kidneys are responsible for concentrating the contents of urine to prevent unnecessary water loss. If water is not conserved, fatal dehydration will occur. The kidneys also reabsorb valuable materials, which leads to further concentration of the waste products. The kidneys use three processes to make sure urine production is concentrated.

A. The blood is filtered when it passes through the capillaries of the glomerulus. This filtration only allows small solutes to pass, and larger molecules, such as proteins, remain in the bloodstream.

B. Reabsorption occurs in the renal tubule. Here water and nutrients are taken from the filtrate and put into the peritubular fluid. The reabsorbed materials eventually rejoin the blood.

C. Secretion is the process of transporting any remaining undesirable solutes from the peritubular fluid into the tubular fluid. Therefore, those waste products that are not filtered in the glomerulus can still be eliminated in the renal tubule.

III. Glomerular Filtration

The fluid that is filtered in the renal corpuscle must pass across three physical barriers in the glomerulus. These barriers include the capillary endothelium, the basement membrane, and filtration slits.

A. The capillary endothelium has pores that do not allow blood cells to pass. The pores are large enough for solutes and plasma proteins to pass.

B. The basement membrane that surrounds the capillary endothelium is denser and does not allow large plasma proteins to pass. However, small plasma proteins, ions, and nutrients can pass through the basement membrane.

C. The filtration slits are the last of the physical barriers. These slits permit only the smallest plasma proteins, ions, and small organic molecules to pass.

IV. Filtration Pressures

Filtration in the kidneys is possible because of the pressures that are exerted on the fluid as it passes through the glomerulus. There are three different types of pressures associated with filtration.

A. Hydrostatic pressure pushes water and solutes out of the plasma and into the intercapsular space. Net hydrostatic pressure is determined by the difference in glomerular hydrostatic pressure and capsular hydrostatic pressure.

B. Colloid osmotic pressure is created by the presence of proteins in the fluid. Therefore, since the concentration of proteins in the plasma is higher, water tends to pull toward the plasma. This opposes filtration. If the glomeruli are damaged the opposite situation may occur.

C. Net filtration pressure is the difference in the net hydrostatic pressure and the net colloid pressure. Net filtration pressure should be NFP = NHP – NCOP = 10 mm Hg.

V. Urine Transport, Storage, and Elimination

A. The ureters are muscular tubes that transport the urine from the kidneys to the urinary bladder.

B. The urinary bladder is a muscular organ that holds the urine prior to removal from the body. The walls of the bladder contain rugae that unfold as the bladder fills with urine. A full bladder can hold approximately a liter of urine.

C. The urethra is a tube that joins the urinary bladder to the exterior. In males the urethra is longer because it extends to the end of the penis. In both males and females the urethra passes through the external urethral sphincter that must relax before urination can occur.

Lecture 21
Male Reproductive System

I. General Characteristics of the Male Reproductive System

The gonads, which are testes in males, are the reproductive organs that produce gametes and hormones. The testes produce sex hormones called androgens. The male reproductive system also has ducts that carry the gametes, and accessory glands that secrete fluids in addition to sperm. The sperm cells are produced in the testes and then travel through the epididymus, the ductus deferens, the ejaculatory duct, and finally the urethra. The seminal vesicles, the prostate gland, and the bulbourethral glands are the accessory glands that secrete fluids into the ejaculatory ducts. The penis and the scrotum are the external genitalia of the male reproductive system.

II. The Testes

The testes, located in the scrotum, are where spermatogenesis takes place. Early in fetal development, the testes are located next to the kidneys, and by birth the testes have descended into the scrotum. Sperm is produced within the seminiferous tubules that are coiled within the lobules of the testes. Interstitial cells within the testes produce androgens, of which testosterone is the most important.

III. Spermatogenesis

Spermatogenesis takes place in three steps.

A. Spermatogonia go through the stages of mitosis and produce daughter cells that differentiate into spermatocytes.

B. The spermatocytes then undergo meiosis within the seminiferous tubules. The spermatids that are formed contain only twenty-three chromosomes.

C. The spermatids are unspecialized cells that undergo spermiogenesis. The process of spermiogenesis creates spermatozoa, fully mature sperm.

IV. Sustentacular Cells

Sustentacular cells of the seminiferous tubules provide several important functions in the formation of spermatozoa.

A. They help maintain the blood-testis barrier.

B. The sustentacular cells must be stimulated by follicle-stimulating hormone before mitosis and meiosis can take place.

C. They provide nutrients and chemicals needed for spermatozoa maturation.

D. They secrete inhibin, a hormone that regulates the pituitary release of follicle-stimulating hormone and gonadotropin-releasing hormone.

E. They secrete androgen-binding protein, which increases the levels of androgens in the seminiferous tubules and thereby stimulating spermiogenesis.

F. They secrete Mullerian-inhibiting factor, which is important in allowing the proper descent of the testes.

V. The Male Reproductive Tract

A. Once sperm leave the seminiferous tubules, they enter the epididymus. The epididymus recycles damaged sperm, and as the sperm pass through, they become functionally mature.

B. The sperm enters the ductus deferens after leaving the epididymus. The ductus deferens open up in an area called the ampulla and then joins the urethra, where the sperm leaves the body.

VI. The Glands of the Male Reproductive Tract

While spermatogenesis takes place in the testes, other structures of the male reproductive system aid in the maturation, nourishment, and transport of sperm.

A. The seminal vesicles produce the vesicular fluid that makes up sixty percent of semen. Vesicular fluid provides nourishment to the spermatozoa, and it activates sperm. The vesicular fluid also acts as a buffer against the acidity of the vagina and forms a fibrinogen clot in the vagina after ejaculation.

B. The prostate gland produces a slightly acidic, prostatic fluid. This fluid contains seminalplasmin, which is an antibiotic that may prevent urinary tract infections.

VII. The Penis

The penis consists of three segements called the root, the body, and the glans. The penis is responsible for transporting urine out of the body and inserting semen into the female vagina. The prepuce, or foreskin, is generally removed shortly after birth in most countries, in a process called circumcision. Within the penis, there are three columns of erectile tissue made up of blood vessels, elastic connective tissue, and smooth muscle. When at rest, the blood vessels are constricted and the muscle tissue is tense preventing blood flow to the penis. When stimulated, the parasympathetic nervous system causes the muscle tissue to relax, and blood flows to the penis making it erect.

Lecture 22
Female Reproductive System

I. General Characteristics of the Female Reproductive System

The female reproductive system is responsible for the formation of the gametes, or eggs, and for providing a suitable place for the developing embryo. The organs of the female reproduction include the ovaries, the Fallopian tubes, the uterus, and the vagina.

II. The Ovaries

The ovaries produce oocytes, or immature gametes and secrete estrogens, progestins, and inhibin. Oogenesis takes place in the ovaries. The formation of oocytes begins during fetal development, and by birth, approximately two million primary oocytes have formed in the ovaries. At puberty, the release of oocytes begins in a process known as the ovarian cycle.

III. The Ovarian Cycle

Each month the female reproductive system goes through a series of steps to prepare the oocytes for fertilization.

A. The ovarian cycle begins as FSH from the pituitary gland stimulates the development of primary follicles. Granulosa and thecal cells form around the follicle, and these cells together produce estrogens.

B. The primary follicle then begins producing follicular fluid, increases in size, and becomes a secondary follicle.

C. Next, the tertiary follicle forms. After it forms, LH levels increase and meiosis continues until the metaphase stage of meiosis II is reached. The follicle will stay at this stage unless fertilization occurs.

D. The follicular wall breaks releasing the secondary oocyte. This is called ovulation.

E. The remaining tertiary follicle forms the corpus luteum, which releases progestins and prepares the uterus for pregnancy.

F. If fertilization does not occur, fibroblasts break down the corpus luteum and hormone levels fall. The cycle then begins again.

IV. The Fallopian Tubes

The Fallopian tubes are muscular tubes that are divided into three regions called the infundibulum, the ampulla, and the isthmus. The Fallopian tubes transport the oocyte from the ovary to the uterus, and fertilization usually occurs near the ampulla-isthmus boundary. The tubes also provide nutrients to the sperm and developing embryo.

V. The Uterus

The uterus provides a safe and nutrient-rich environment for the developing embryo and fetus. The muscles in the uterine wall contract during labor to deliver the baby. The cervix is a tubular boundary between the uterus and vagina and is the site for the most common type of cancer in the female reproductive system.

VI. The Uterine Cycle

The uterine, or menstrual, cycle corresponds with the ovarian cycle. The uterus goes through a variety of changes, which are controlled by the hormones produced in the ovarian cycle. Menarche marks the onset of the uterine cycle at puberty, while menopause refers to the end of the uterine cycle in middle-aged women.

A. Menses, the first phase, corresponds with the first seven days of the ovarian cycle. Menses is characterized by blood loss and sloughing of the endometrium in a process commonly known as menstruation.

B. During the proliferative phase, the endometrium is restored. Estrogens produced by the follicle activate and sustain the proliferative phase.

C. During the secretory phase, the endometrial glands enlarge and secretion increases. Hormones from the corpus luteum stimulate this phase, which then ends when the corpus luteum disintegrates.

VII. The Vagina

The vagina is a muscular tube that extends from the cervix to the exterior of the body. The vagina provides three important functions. It provides a pathway for the removal of menstrual fluid. It serves as reception site for sperm, and it acts as a birth canal for the fetus during delivery.

Lecture 1
The Endocrine System

I. Cellular Communication

A. Direct communication –

B. Paracrine communication –

C. Endocrine communication –

D. Synaptic communication –

II. Chemical Structure of Hormones

A. Amino Acid Derivatives –

B. Peptide Hormones –

C. Lipid Derivatives –

III. Hormone Transport

IV. Hormone Function

A. Cytoplasm receptor sites –

B. Second-messenger Systems

Lecture 2
The Endocrine System

I. Control of the Endocrine System

A. Endocrine reflexes –

B. Complex Endocrine Reflexes –

C. Neuroendocrine reflexes –

II. The Pituitary Gland

A. The following hormones are secreted from the anterior pituitary.

1. Thyroid-stimulating hormone (TSH) –

2. Adrenocorticotropic hormone (ACTH) –

3. Follicle-stimulating hormone (FSH) –

4. Lutenizing hormone (LH) –

5. Prolactin –

6. Growth hormone –

7. Melanocyte-stimulating hormone (MSH) –

B. The following hormones are produced in the posterior pituitary gland.

1. Antidiuretic hormone (ADH) –

2. Oxytocin –

III. The Thyroid Gland

IV. The Parathyroid Gland

V. The Thymus

Lecture 3
The Adrenal Glands

I. The Adrenal Glands

A. The adrenal cortex –

1. The zona glomerulosa –

2. The zona fasciculata –

3. The zona reticularis –

B. The adrenal medulla –

II. The Kidneys

A. Calcitriol –

B. Erythropoietin –

C. Renin –

III. The Heart

IV. The Pancreas

A. Alpha cells –

B. Beta cells –

C. Delta cells –

D. F cells –

Lecture 4
Endocrine System

I. The Reproductive System

A. Androgens –

B. The ovaries –

II. The Pineal Gland

III. Interaction of Hormones

IV. Hormonal Effect on Growth

Several hormones influence the rate of growth of the human body.

A. Growth hormone –

B. Thyroid hormones –

C. Insulin –

D. Parathyroid hormone and calcitriol –

E. Hormones produced in the reproductive system of both males and females –

V. Stress

A. The alarm phase –

B. The resistance phase –

C. The exhaustion phase –

Lecture 5
Endocrine Disorders

I. Acromegaly

II. Pituitary Growth Failure

III. Diabetes Insipidus

IV. Diabetes Mellitus

V. Hypothyroidism

VI. Hyperthyroidism

VII. Hypoparathyroidism

VIII. Hyperparathyroidism

IX. Hypoaldosteronism

X. Aldosteronism

XI. Addison's Disease

XII. Cushing's Disease

XIII. Andrenogenital Syndrome

XIV. Goiter

Lecture 6
Blood

I. Introduction to Blood

II. Plasma

A. Albumins –

B. Globulins –

C. Fibrinogen proteins –

III. Red Blood Cells

IV. Hemoglobin

V. Blood Types

Lecture 7
Blood

I. White Blood Cells

A. Neutrophils –

B. Eosinophils –

C. Basophils –

D. Monocytes –

E. Lymphocytes –

II. White Blood Cell Count

III. White Blood Cell Production

IV. Platelets

V. Hemostasis

A. The vascular phase –

B. The platelet phase –

C. The coagulation phase –

D. Actin and myosin filaments –

E. Fibrinolysis –

Lecture 8
The Heart

I. General Characteristics of the Cardiovascular System

II. Anatomy of the Heart

A. The right atrium –

B. The right ventricle –

C. The left atrium –

D. The left ventricle –

E. The heart wall –

IV. The Heartbeat

A. Contractile cells –

B. The conducting system –

V. The Cardiac Cycle

Lecture 9
Circulation

I. General Anatomy of Blood Vessels

II. The Differences between Veins and Arteries

Although the basic structure between veins and arteries is similar, there are some differences between the two types of vessels.

A.

B.

C.

D.

E.

F.

G.

III. Arteries

A. Elastic arteries –

B. Muscular arteries –

C. Arterioles –

IV. Disorders of the Arteries

A. Arteriosclerosis –

1. Focal calcification –

2. Atherosclerosis –

B. Aneurysms –

V. Capillaries

A. Continuous capillaries –

B. Fenestrated capillaries –

VI. Veins

A. Venules –

B. Medium-sized veins –

C. Larges veins –

VII. Venous Valves

Lecture 10
Cardiovascular Physiology

I. Blood Flow

A. The hydrostatic pressure –

B. Resistance –

C. Viscosity –

D. Turbulence –

II. Capillary Exchange

A. Diffusion –

B. Filtration –

C. Reabsorption –

III. Venous Return

A. Muscular contractions –

B. The respiratory pump –

IV. Cardiovascular Regulation

A. Local factors –

B. The nervous system –

V. Baroreceptors

VI. Chemoreceptors

VII. Endocrine Control of Circulation

VIII. Exercise and the Cardiovascular System

IX. Shock

A. The compensated stage –

B. The progressive stage –

C. The irreversible stage –

Lecture 11
The Lymphatic System and Nonspecific Immunity

I. General Characteristics of the Lymphatic System

II. Lymphatic Vessels

A. Lymphatic capillaries –

B. Lymphatic vessels –

III. Lymphocytes

A. T cells –

B. B cells –

C. NK –

IV. Lymphocyte Production

V. Lymphoid Tissues

VI. Lymphoid Organs

A. Lymph nodes –

B. The thymus –

C. The spleen –

VII. Nonspecific Immune Response

Lecture 12
Specific Immune Response

I. Specific Immune Response

II. Types of Immunity

A. Innate immunity –

B. Acquired immunity –

1. Active immunity –

2. Passive immunity –

III. Properties of immunity

When immune response is specific resistance, it has certain characteristic properties.

A. Specificity –

B. Versatility –

C. Memory –

D. Tolerance –

IV. T Cell Activation

A. Class I MHC proteins –

B. Class II MHC proteins –

V. Cluster Designation (CD) Markers

VI. Steps of T Cell Immunity

A.

B.

C.

D.

E.

F.

VII. Antibody-Mediated Immunity

VIII. Antibody Structure

IX. Antibody Action

Lecture 13
General Anatomy of the Respiratory System

I. Functions of the Respiratory System

II. The Upper Respiratory System

III. The Larynx

IV. The Trachea

V. The Primary Bronchi

Lecture 14
The Lungs

I. General Anatomy of the Lungs

II. The Bronchi

III. The Bronchioles

IV. Alveoli

V. Tuberculosis

VI. Pneumonia

VII. Birth and the Respiratory System

Lecture 15
Process of Respiration

I. Basics of Respiration

II. Pulmonary Ventilation

A. Boyle's Law –

B. The respiratory cycle –

C. The diaphragm and intercostal muscles –

D. Eupnea –

E. Hypernea –

F. Respiratory rate –

III. Pulmonary Performance

E. Resting tidal volume –

F. The expiratory reserve –

G. Residual volume –

H. The inspiratory reserve volume –

I. Inspiratory capacity –

J. Functional residual capacity –

K. Vital capacity –

L. Total lung capacity –

IV. Hemoglobin and Oxygen Transport

V. Carbon Dioxide Transport

VI. Respiratory Control

Lecture 16
The Digestive System

I. Digestive Functions

A. Ingestion –

B. Physical manipulation –

C. Digestion –

D. Secretion –

E. Absorption –

F. Excretion –

II. Layers of the Digestive Tract

A. The mucosa –

B. The submucosa –

C. The muscularis externa –

D. The serosa –

III. Smooth Muscle Movement

A. Peristalsis –

B. Segmentation –

IV. Regulation of Digestion

VI. The Peritoneum

VII. Oral Cavity

A. The mouth –

B. The tongue –

C. The salivary glands –

D. The teeth –

Lecture 17
The Digestive System

I. The Pharynx

II. The Esophagus

III. Swallowing

A. The buccal phase –

B. The pharyngeal phase –

C. The esophageal phase –

IV. Anatomy of the Stomach

A. The cardia –

B. The fundus –

C. The body –

D. The pylorus –

VI. Gastric Glands

A. The parietal cells –

B. The chief cells –

VII. Pyloric Glands

VIII. Regulation of Digestion

A. In the cephalic phase –

B. In the gastric phase –

C. In the intestinal phase –

Lecture 18
The Digestive System

I. Anatomy of the Small Intestine

A. The duodenum –

B. The jejunum –

C. The ileum –

II. Structures of the Small Intestine

A. Plicae –

B. Intestinal villi –

C. Intestinal crypts –

D. Submucosal glands –

E. Lymphoid nodules –

III. The Pancreas

IV. The Liver

VI. The Gallbladder

VII. The Large Intestine

Lecture 19
The Urinary System and Kidney Function

I. Functions of the Urinary System

II. Overview of Kidney Anatomy

A. The renal capsule –

B. The adipose capsule –

C. The renal fascia –

D. The hilus –

E. The renal sinus –

F. The renal cortex –

G. The renal medulla –

H. The renal lobe –

III. The Nephron

IV. Blood and Nerve Supply to the Kidneys

Lecture 20
Renal Physiology

I. Composition of Urine

A. Urea –

B. Creatinine –

C. Uric acid –

II. Concentration of Urine

A. Filtration –

B. Reabsorption –

C. Secretion –

III. Glomerular Filtration

A. The capillary endothelium –

B. The basement membrane –

C. The filtration slits –

IV. Filtration Pressures

A. Hydrostatic pressure –

B. Colloid osmotic pressure –

C. Net filtration pressure –

V. Urine Transport, Storage, and Elimination

A. The ureters –

B. The urinary bladder –

C. The urethra –

Lecture 21
Male Reproductive System

I. General Characteristics of the Male Reproductive System

II. The Testes

III. Spermatogenesis

IV. Sustentacular Cells

V. The Male Reproductive Tract

VI. The Glands of the Male Reproductive Tract

A. The seminal vesicles –

B. The prostate gland –

VII. The Penis

Lecture 22
Female Reproductive System

I. General Characteristics of the Female Reproductive System

II. The Ovaries

III. The Ovarian Cycle

IV. The Fallopian Tubes

V. The Uterus

VI. The Uterine Cycle

A. Menses –

B. The proliferative phase –

C. The secretory phase –

VII. The Vagina

Name ________________________________ Section ______ Date _____________

Anatomy and Physiology II
Exam I

Multiple Choice (2 points each)

_____ 1. The primary purpose of the endocrine system is

A. support B. protection
C. communication D. sensory perception

_____ 2. Which of the following is NOT a characteristic of endocrine communication?

A. hormones travel in blood B. hormones have specific receptor sites
C. hormones are produced in glands D. hormones only communicate in local areas

_____ 3. Hormones are made of

A. amino acids B. carbohydrates
C. salts D. buffers

_____ 4. The adrenal glands are located near the

A. liver B. ovaries
C. brain D. kidneys

True/False (2 points each)

_____ 5. Steroid hormones are lipid derivatives.

_____ 6. The two major subdivisions of the adrenal glands are the adrenal cortex and the adrenal medulla.

_____ 7. The adrenal medulla secretes more norepinephrine than epinephrine.

_____ 8. The pancreas produces insulin.

_____ 9. The adrenal glands produce glucagon.

_____ 10. Testosterone is an androgen that is produced in the testes.

_____ 11. When different hormones are released into the bloodstream, they do not affect each other.

Cellular Communication – Matching (2 points each)

_____ 12. Direct communication A. local; attach to sites in surrounding tissue

_____ 13. Paracrine communication B. occurs in neural tissue

_____ 14. Endocrine communication C. occurs at gap junctions

_____ 15. Synaptic communication D. chemical messengers in the blood

Multiple Choice (2 points each)

_____ 16. Which of the following are characteristics of the adrenal medulla?

A. highly vascularized B. red in color

C. secretes epinephrine **D. all the above**

_____ 17. Beta cells in the pancreas

A. produce insulin B. produce glucagon

C. produce somatostatin D. produce renin

_____ 18. The following are produced in the ovaries **except**

A. estrogens B. estradiol

C. FSH D. progestins

_____ 19. Seasonal affective disorder may occur because of changes in _____________ production.

A. insulin B. melatonin

C. FSH D. inhibin

_____ 20. The alarm phase, resistance phase, and exhaustion phase are all part of

A. seasonal affective disorder (SAD) B. diabetes

C. acromegaly D. general adaptation syndrome (GAS)

_____ 21. Hormones produced in reproductive organs are regulated by the?

A. adrenal glands B. parathyroid gland

C. pineal gland D. pituitary gland

_____ 22. The pineal gland produces

A. melanin B. melatonin

B. insulin D. epinephrine

Endocrine Disorders – Matching (2 points each)

_____ 23. Acromegaly A. rare; insufficient glucocorticoids are produced

_____ 24. Diabetes Insipidus B. increase in GH production

_____ 25. Diabetes Mellitus C. decrease in ADH secretion

_____ 26. Addison's disease D. improper insulin production

_____ 27. Cushing's disease E. excess of glucocorticoids

Pituitary Gland – Matching (2 points each)

_____	28. Follicle-stimulating hormone	A. triggers labor contractions
_____	29. Prolactin	B. triggers growth in all cells
_____	30. Growth hormone	C. stimulates sperm maturation
_____	31. Oxytocin	D. stimulates ovulation
_____	32. Lutenizing hormone	E. triggers milk production

Pituitary Gland – Matching (2 points each)

_____	33. Thyroid-stimulating hormone	A. affects the epidermis
_____	34. Adrenocorticotropic hormone	B. triggers reabsorption of water
_____	35. Melanocyte-stimulating hormone	C. targets the thyroid gland
_____	36. Antidiuretic hormone	D. stimulates release of glucocorticoids

Multiple Choice (2 points each)

_____ 37. Which two hormones are produced in the posterior pituitary gland?
A. ADH and ACTH	B. Growth hormone and prolactin
C. Oxytocin and ADH	D. Oxytocin and lutenizing hormone

_____ 38. Which gland may explain why the elderly have more health problems?
A. Thyroid	B. Pancreas
C. Adrenal	D. Thymus

_____ 39. Endocrine reflexes
A. trigger hormone secretion	B. are only found in the pituitary gland
C. begin in the adrenal gland	D. are tested using a mallet below the knee

_____ 40. Having high levels of glucose in the urine is a symptom of
A. Diabetes Insipidus	B. Diabetes Mellitus
C. Acromegaly	D. Hyperthyroidism

_____ 41. This gland secretes a hormone that inhibits bone growth
A. Thyroid gland	B. Pancreas
C. Parathyroid gland	D. Pineal gland

_____ 42. Hormones can alter cells by
A. turning on specific genes	B. deactivating a specific enzyme
C. increasing production of an enzyme	D. only A and C	E. all of the above

_____ 43. The pituitary gland is controlled by the
A. hypothalamus B. thyroid
C. parathyroid D. pineal gland

_____ 44. Which of the following is **not** a result of secretion from the thyroid gland?
A. Osteoclasts are stimulated B. energy use increases
C. growth and development increases D. all are a result of thryoid gland secretions

_____ 45. Anything that alters the physiological response in the body is called
A. a hormone B. stress
C. resistance D. communication

Short Answer (5 points each)
46. Draw and label a simple sketch of the adrenal gland.

47. Choose one endocrine disorder and briefly describe the role that hormones play in that particular disorder.

Name ____________________________________ Section ______ Date _____________

Anatomy and Physiology II
Exam II

Multiple Choice (2 points each)

_____ 1. Red blood cells
A. fight off pathogens B. carry oxygen and carbon dioxide
C. carry out phagocytosis D. destroy damaged cells

_____ 2. Erythrocytes
A. contain hemoglobin B. are the most numerous blood cell
C. form rouleaux D. all the above

_____ 3. Albumins, globulins, and fibrinogens are found in
A. plasma B. white blood cells
C. red blood cells D. platelets

_____ 4. The blood type that is the universal donor is
A. A B. B
C. AB D. O

_____ 5. Phagocytosis is the process of
A. forming blood clots B. engulfing pathogens
C. creating osmotic pressure D. regulating body temperature

_____ 6. The most numerous white blood cell, and the one that reaches an injury site first is the
A. basophil B. lymphocyte
C. neutrophil D. eosinophil

_____ 7. What will happen to the white blood cell count if there is an infection in the body?
A. WBC count will decrease B. WBC count will increase
C. WBC count will stay the same D. infection does not affect WBC count

Blood – Matching (2 points each)

_____	8. Platelets	A. aggressive, phagocytic
_____	9. Plasma	B. contain hemoglobin
_____	10. Monocytes	C. work with mast cells; release histamine
_____	11. Basophils	D. form clots at injury sites
_____	12. Red blood cells	E. makes up 50% of whole blood

Multiple Choice (2 points each)

_____ 13. Pulmonary vessels carry blood to and from the _______________, while systemic vessels carry blood to and from the _______________.

A. lungs, body tissues B. body tissues, lungs
C. brain, body tissues D. lungs, brain

_____ 14. Unoxygenated blood that has traveled through body tissues enters the

A. right ventricle B. right atrium
C. left ventricle D. left atrium

_____ 15. The opening in the heart that should close shortly after birth is called the

A. atrioventricular valve B. semilunar ovale
C. foramen ovale D. semilunar valve

_____ 16. ________________ means that the heart will pump without neural or hormonal control.

A. Hemostasis B. Automaticity
C. Conduction D. Coordination

_____ 17. Which cells produce the contractions that create blood flow?

A. Contractile cells B. Myocardial cells
C. Systemic cells D. atrioventricular cells

True/False (2 points each)

_____ 18. Action potentials in cardiac muscle are shorter than in skeletal muscle.

_____ 19. The outer layer of the heart is the epicardium.

_____ 20. The superior vena cava receives blood from the trunk and lower limbs.

_____ 21. The left atrium contain oxygenated blood.

_____ 22. The three layers of a blood vessel are the tunica interna, the tunica media, and the tunica externa.

_____ 23. The systole phase of a chamber occurs when it is pushing blood into another chamber or artery.

_____ 24. Aneurysms occur when a weakened wall in an artery bursts.

Multiple Choice (2 points each)

_____ 25. Arteriosclerosis occurs when

A. weakened walls of an artery burst B. artery walls thicken and toughen
C. the foramen ovale does not close D. the heartbeat is not coordinated

_____ 26. Varicose veins are a result of

A. hypertension B. hypotension

C. weakened valves in veins D. inefficient venous return

_____ 27. Blood flow is affected by

A. viscosity B. hydrostatic pressure

C. turbulence D. resistance E. all the above

_____ 28. Anemia most affects the _______________ of blood.

A. viscosity B. hydrostatic pressure

C. turbulence D. resistance

_____ 29. When small molecules pass through the capillary wall from high concentration to low concentration, it is called

A. resistance B. diffusion

C. filtration D. reabsorption

_____ 30. Which factors affect the efficiency of venous return?

A. viscosity and diffusion B. muscular contraction and respiratory pump

C. osmosis and resistance D. osmosis and the respiratory pump

_____ 31. What condition results if there is a large amount of blood loss in a person?

A. hypertension B. arteriosclerosis

B. shock D. Marfan's syndrome

Veins and Arteries – Matching (2 points each)

Mark **A** if it is a characteristic of an artery.

Mark **B** if it is a characteristic of a vein.

_____ 32. Carries blood away from the heart to body tissues.

_____ 33. More resilient to distortion.

_____ 34. Contains valves.

_____ 35. Contains thicker walls.

_____ 36. More likely to retain its shape.

_____ 37. Contains more smooth muscle.

Cardiovascular Physiology – Matching (2 points each)

_____ 38. Baroreceptors A. alter capillaries in the immediate area

_____ 39. Chemoreceptors B. stimulates vasoconstriction to increase blood pressure

_____ 40. ADH C. in the right atrium; stimulates the nervous system

_____ 41. Local Factors D. activated by changes in oxygen level of the blood

_____ 42. Erythropoietin E. activates red blood cell production

Multiple Choice (2 points each)

_____ 43. If you find someone in the progressive stage of shock you should
A. seek immediate medical help B. let the person rest
C. administer CPR D. give up; the person is beyond help

_____ 44. What is NOT an effect of exercise on the cardiovascular system?
A. larger stroke volume B. reduction in venous return
C. slower heart rate D. more efficiently working heart

_____ 45. The cardiovascular centers of the nervous system are found in the
A. medulla oblongata B. hypothalamus
C. cerebrum D. amygdala

_____ 46. Arteriosclerosis might be a result of
A. Marfan's syndrome B. varicose veins
C. diabetes mellitus D. a heart murmur

_____ 47. Which of the following might result in a patient's death during a blood transfusion?
A. giving type A blood to a person with type A blood
B. giving type O blood to a person with type B blood
C. giving type AB blood to a person with type O blood
D. giving type B blood to a person with type AB blood

Short Answer (6 points)

48. Draw and label a simple sketch of blood flow through the heart and lungs.

Name ____________________________________ Section ______ Date _____________

Anatomy and Physiology II
Exam III

Multiple Choice (2 points each)

_____ 1. A pathogen is a

A. disease-causing agent B. lymphocyte
C. a section of bone marrow D. cell produced by bone marrow

_____ 2. The lymphatic system is responsible for

A. distributing nutrients in the body B. carrying oxygen
C. providing immune response D. cleaning the blood

_____ 3. What cells make up the majority of lymphocytes

A. RBCs B. T cells
C. antibodies D. antigens

_____ 4. The tissue responsible for creating lymphocyte stem cells is

A. the thymus B. RBCs
C. lymphoid tissue D. bone marrow

_____ 5. Which of the following organs are involved in lymphocyte activity

A. spleen and thymus B. pancreas and spleen
C. liver and thymus D. pancreas and thymus

_____ 6. Which of the following would NOT occur in response to a nonspecific pathogen

A. fever B. inflammation
C. immunological surveillance D. creation of antibodies

_____ 7. The immune system is able to attack specific antigens by

A. fever B. inflammation
C. immunological surveillance D. creation of antibodies

Immunity – Matching (2 points each)

_____	8. Spleen	A. in reserve for future infections
_____	9. Helper T cells	B. removes abnormal material from blood
_____	10. Memory B cells	C. attack foreign cells
_____	11. Plasma cells	D. produce antibodies
_____	12. Cytotoxic T cells	E. activate T cells and B cells

Multiple Choice (2 points each)

_____ 13. __________________ refers to the immune system's ability to produce a variety of antibodies, while __________________ occurs when the body does not respond to a specific antigen.

A. Specificity, memory
B. Versatility, tolerance
C. Tolerance, versatility
D. Versatility, specificity

_____ 14. How many classes of MHC proteins are there?

A. 1
B. 2
C. 3
D. 4

_____ 15. The MHC proteins are found in the cell membranes of all cells

A. Class I
B. Class II

_____ 16. After a T cell has recognized an antigen, why must it undergo costimulation?

A. to create of more T cells
B. to prevent attack of healthy cells
C. to supress B cells
D. T cells do not undergo costimulation

_____ 17. Low oxygen levels in body tissues result in

A. hypoxia
B. apoxia
C. hyperpoxia
D. superpoxia

True/False (2 points each)

_____ 18. Boyle's Law explains how air pressure differences between the lungs and the outside environment cause air to enter and exit the lungs.

_____ 19. Eupnea is forced breathing and involves the use of more muscles.

_____ 20. Gas exchange takes place in the alveoli.

_____ 21. Measurements of pulmonary performance can help diagnose respiratory problems.

_____ 22. The majority of oxygen is carried in blood plasma.

_____ 23. White blood cells contain hemoglobin.

_____ 24. Carbonic acid is produced when carbon dioxide enters the bloodstream.

Multiple Choice (2 points each)

_____ 25. The involuntary respiratory centers are found in the

A. hippocampus
B. medulla oblongata
C. cerebellum
D. hypothalamus

_____ 26. Which of the following is NOT a function of the nasal cavity?
A. moistens incoming air B. main pathway for incoming air
C. traps debris D. prevents food from entering the lungs

_____ 27. The thyrid cartilage creates
A. the Adam's apple B. the voice box
C. the nose D. oropharynx

_____ 28. Because it joins at a steeper angle, the _________ usually traps foreign objects.
A. right primary bronchus B. left primary bronchus

_____ 29. The left lung is slightly narrower than the right lung because
A. the right lung is more powerful B. it allows room for the heart
C. blood enters the right lung first D. both lungs are the same shape

_____ 30. _______________ help prevent the trachea from collapsing.
A. Cartilaginous rings B. Alveoli
C. Smooth muscles D. Small bones

_____ 31. ______________ is an infectious bacterial disease that is characterized by fever, coughing, chest pain, and weight loss.
A. Pneumonia B. Tuberculosis
B. Cystic Fibrosis D. Emphysema

Respiratory System – Matching (2 points each)

_____ 32. Larynx	A. number of breaths per minute
_____ 33. Pharynx	B. vital capacity + residual volume
_____ 34. Total lung capacity	C. can carry four molecules of oxygen
_____ 35. Respiratory rate	D. open chamber
_____ 36. Hemoglobin	E. contains vocal ligaments

True/False (2 points each)

_____ 37. B cells differentiate into plasma cells, which then produce antibodies.

_____ 38. All lymphocytes are produced in bone marrow.

_____ 39. Lymph nodes respond to local infection.

_____ 40. Inflammation accelerates the metabolism to fight infection.

_____ 41. Active immunity occurs when antibodies for a specific antigen are given.

_____ 42. Breathing through the mouth is better than breathing through the nose.

_____ 43. Bronchoconstriction, possibly resulting from asthma, occurs when the bronchioles increase in diameter.

_____ 44. The intercostal muscles can help the diaphragm increase lung volume.

_____ 45. Breathing is always an involuntary action.

Short Answer (10 points each)
46. List five ways the antibody-antigen complex can eliminate antigens.

Name ____________________________________ Section ______ Date _____________

Anatomy and Physiology II
Final Exam

Multiple Choice (2 points each)

_____ 1. The chemical breakdown of food into energy is called

A. secretion B. absorption
C. digestion D. ingestion

_____ 2. This layer is responsible for moving materials through the digestive tract

A. mucosa B. muscularis externa
C. submucosa D. lamina propria

_____ 3. _________________ involves the churning and mixing of materials.

A. Segmentation B. Excretion
C. Peristalsis D. histology

_____ 4. Movement of material from the small intestine to the large intestine is done by _________________.

A. Segmentation B. Excretion
C. Peristalsis D. histology

_____ 5. Which of the following is not a function of the tongue?

A. manipulates food in the mouth B. secretes mucus
C. secretes *lingual lipase* D. secretes *salivary amylase*

_____ 6. An adult with no teeth missing has _____ teeth.

A. 28 B. 30
C. 32 D. 34

_____ 7. The voluntary phase of swallowing is the ___________ phase.

A. buccal B. pharyngeal
C. esophageal D. fundus

Oral Cavity – Matching (2 points each)

_____ 8. *Salivary amylase* A. useful for tearing food

_____ 9. Incisors B. lubricates food

_____ 10. Molars C. useful for clipping and cutting food

_____ 11. Saliva D. breaks down starches

_____ 12. Cuspids E. crush and grind food

Multiple Choice (2 points each)

_____ 13. Why is mucous in the digestive system important?

A. protects tissue from acids B. protects tissue from enzymes
C. both A and B D. none of the above

_____ 14. The cephalic phase of digestion is stimulated by

A. entrance of food into the stomach B. chyme entering the small intestine
C. pancreatic activity D. seeing or tasting food

_____ 15. Most nutrient absorption in the small intestine takes place in the

A. duodenum B. jejunum
C. ileum D. pylorus

_____ 16. Which of the following is NOT a function of the large intestine?

A. reabsorbs water B. stores fecal material
C. rids the body of old RBCs D. condenses material into feces

_____ 17. Which of the following are waste products created in the body?

A. urea B. creatinine
C. uric acid D. all of the above

True/False (2 points each)

_____ 18. The pancreas does not directly affect the digestive system, only indirectly through the production of insulin.

_____ 19. The gallbladder produces bile, while the liver stores bile.

_____ 20. The purpose of the PCT is to reabsorb nutrients, ions, and plasma proteins.

_____ 21. The glomerulus helps to filter the blood.

_____ 22. The urethra transports urine from the kidneys to the urinary bladder.

_____ 23. Hydrostatic pressure and colloid osmotic pressure work against each other.

_____ 24. Healthy kidneys allow a substantial amount of proteins into the urine.

Multiple Choice (2 points each)

_____ 25. In males, androgen are produced by

A. interstitial cells B. spermatids
C. sustentacular cells D. the prostate gland

_____ 26. Damaged sperm are recycled in the

A. prostate gland B. seminal vesicles
C. epididymus D. penis

_____ 27. Gametes contain _____ chromosomes.

A. 23 B. 46

C. 22 D. 44

_____ 28. ______________ is released by the pituitary gland in both males and females to stimulate gamete production.

A. Inhibin B. Testosterone

C. Progesterone D. Follicle-stimulating hormone

_____ 29. Reproductive organs are called

A. gametes B. oocytes

C. gonads D. hormones

_____ 30. The onset of the uterine cycle at puberty is called

A. menarche B. menopause

C. oogenesis D. follicle formation

_____ 31. Fertilization generally takes place in the

A. vagina B. penis

B. ovary D. Fallopian tube

Reproduction – Matching (2 points each)

_____ 32. Ovary	A. secretes progestins
_____ 33. Corpus luteum	B. where oogenesis takes place
_____ 34. Mullerian-inhibiting factor	C. comprised of the root, body, and glans
_____ 35. Penis	D. protects the fetus
_____ 36. Uterus	E. important in the descent of testes in the fetus

True/False (2 points each)

_____ 37. Vesicular fluid nourishes and activates sperm.

_____ 38. The penis becomes erect when blood flow to the erectile tissue stops.

_____ 39. The levels of LH rise as ovulation approaches.

_____ 40. The ovarian and uterine cycles are the exact same cycle, just different names.

_____ 41. Spermatocytes are fully mature sperm cells.

_____ 42. The testes are located in the scrotum at birth.

_____ 43. Prostatic fluid and vesicular fluid provide no functional purpose.

_____ 44. Urine from a healthy person would probably taste sweet.

_____ 45. The urinary system can help control blood pressure.

_____ 46. The liver is responsible for ridding the body of toxins.

_____ 47. Cholecystokinin stimulates secretion of bile from the liver to the duodenum.

_____ 48. Somatostatin enhances the action of gastrin.

_____ 49. Chyme is a basic solution.

_____ 50. Except in the case of an infection, there should be no bacteria in the large intestine.

Anatomy and Physiology II Laboratory
Syllabus

The purpose of the anatomy and physiology lab is to give the student a practical application to the concepts learned in the lecture. Applying concepts of anatomy and physiology concepts to the real world gives us fields such as medicine and related areas.

The material for this course is difficult, and the labs can be time consuming. It will be to your benefit that you read over the lab and answer the pre-lab questions before coming to class each week.

Required Text: Fundamentals of Anatomy and Physiology Laboratory Manual, fourth edition
Authors: Meehan and Martini

Grading will be as follows:

Weekly lab participation	100 pts.
Weekly lab quizzes	90 pts.
Lab final exam	100 pts.
Total points	290 pts.

Weekly lab participation: This grade includes attendance in class and questions that are answered for each lab. One lab grade will be dropped. You may tear out the lab sheet from your lab manual, or you may answer the questions on your own paper to turn in.

Weekly lab quizzes: Quizzes will be given weekly covering the previous week's lab. This is designed to help you better understand the material. One quiz grade will be dropped.

Final exam: The final exam will be comprehensive. The questions on the final will come mainly from lab quizzes.

The semester grade will be determined as follows:

A 259-290 points
B 231-258 points
C 202-230 points
D 173-201 points
Fbelow 173

Lab 1
Endocrine System of the Fetal Pig

This lab examines the major endocrine glands of the fetal pig, and compares those to the human model.

Pre-Lab Activity - Read lab exercise 44b on pages 445-449 in the laboratory manual, and answer the following questions.

- Why do we learn about the human endocrine system when we study the pig?
- What gland will we better be able to see in the fetal pig that will be harder to identify in the adult cat?
- Are all mammalian hormones the same? Explain.
- What glands are found in the brain of the fetal pig?

.

Lab Activity - Follow the listed procedures. Remove each gland, and observe the tissue of each under the dissecting scope. Sketch what you see in the spaces provided.

Post-Lab Activity - Answer these questions after completing the lab activity.

- What section of the brain secretes hormones but is not exactly a gland?
- Were you able to find the parathyroid glands in your fetal pig?
- Were you able to differentiate between the exocrine and endocrine cells of the pancreas? What are the endocrine cells called?
- Where are the adrenal glands in pigs located?

Lab 2
Endocrine System of the Fetal Pig

This lab begins are examination of the cat. We will first look at the endocrine system of the cat and continue throughout the semester as we study the remaining body systems.

Pre-Lab Activity - Read lab exercise 44a on pages 439-443 in the laboratory manual, and answer the following questions.

- What differences might there be between the endocrine system of the fetal pig and the endocrine system of the adult cat?

- Where are the adrenal glands located in the cat as opposed to humans?

.

Lab Activity - Follow the listed procedures. Remove each gland, and observe the tissue of each under the dissecting scope. Sketch what you see in the spaces provided.

Post-Lab Activity - Answer these questions after completing the lab activity.

- List specific differences between the pig and the cat that you observed?

- Were you able to find the parathyroid gland?

- Were you able to find the thymus gland? Was it smaller in the cat than in the fetal pig in relation to their size?

Lab 3
Blood and Blood Testing

This lab will look at the structure of blood and the tests used for determining blood type.

Pre-Lab Activity - Read lab exercises 45 and 46 on pages 451-467 in the laboratory manual, and answer the following questions.

- Describe blood plasma.
- What molecule transports most of the oxygen in the blood?
- Name the three main groups of formed elements in the blood.
- What is sedimentation rate?
- What does the Tallquist Method determine?

.

Lab Activity - Follow the listed procedures in lab 45. For lab 46, you will only do the procedures listed for blood typing on pages 465-466. You will not use your own blood in either lab. Instead, artificial blood will be provided to you. Obtain a sample of artificial blood to use for each section that gives procedures for using your own blood.

Post-Lab Activity - Answer these questions after completing the lab activity.

- After looking at blood under the microscope, which blood cells are the largest?
- Which of the formed elements are not actually true cells?
- What causes sickle-cell anemia?
- In the blood typing experiment, if the anti-B antibody agglutinates the blood, what blood type is your blood?

Lab 4
The Human Heart and Blood Vessels

This lab examines the structures of the human heart and blood vessels.

Pre-Lab Activity - Read lab exercises 47 and 49 on pages 469-477 and 487-497 in the laboratory manual, and answer the following questions.

- List, by chamber, blood flow through the heart?
- What is the opening between the right and left atria that closes at birth?
- What is the pacemaker of the heart called?
- _______________ carry blood away from the heart, while _____________ carry blood to the heart.

.

Lab Activity – Read each lab and look at the diagrams in the book. Also, observe the structures of the heart on the human model and on the dissected sheep heart. Answer the questions in the lab manual for each exercise.

Post-Lab Activity - Answer these questions after completing the lab activity.

- Why is the aorta thicker than the vena cavae?
- While the left and right ventricle hold basically the same volume of blood, why are the walls of the left ventricle so much thicker than the walls of the right ventricle?
- Which vessel layer is considerable larger in arteries than in veins?
- What purpose do valves in veins serve?

Lab 5
Cardiovascular Physiology

In this lab we will look at the condition of your heart. As a note, this lab is not to be used as a diagnostic tool for any cardiovascular disorders. Please consult a physician if you suspect a cardiovascular ailment.

Pre-Lab Activity - Read lab exercises 50 and 51 on pages 501-519 in the laboratory manual, and answer the following questions.

- Where are does the electrical conduction begin in the heart?
- What events cause the “lubb” and “dup” sounds?
- What does an electrocardiograph measure?
- For the ECG reading, how many electrodes are you going to place on your body?

.

Lab Activity - Follow the listed procedures. You will measure your pulse, blood pressure, cardiovascular efficiency, and do an ECG reading. Answer the corresponding questions in the lab manual.

Post-Lab Activity - Answer these questions after completing the lab activity.

- How did your heart rate change from lying to sitting? To standing? To running?
- How did placing your hand in ice affect your blood pressure?
- What did you learn about yourself from the cardiovascular efficiency test?
- What is the right leg always attached to in an ECG?

Lab 6
Cardiovascular System of the Cat

You will continue your dissection of the cat by looking at its cardiovascular system.

Pre-Lab Activity - Read lab exercise 52a on pages 521-531 in the laboratory manual, and answer the following questions.

- What color of latex was injected into the arterial system?

- What color of latex was injected into the venous system?

.

Lab Activity - Follow the listed procedures. Please use caution as you remove tissue and isolate the cardiovascular tissue. You will be required to know the location and name of the major vessels and structures, so identify them as you go.

Post-Lab Activity – You and your lab partner should quiz each other on the various cardiovascular structures.

Lab 7
Respiratory System of the Cat

This lab examines the respiratory system of the cat.

Pre-Lab Activity - Read lab exercise 56a on pages 573-577 in the laboratory manual.

Lab Activity - Follow the listed procedures. Be certain that you identify each part of the respiratory system that is listed in the laboratory manual.

Post-Lab Activity - Answer these questions after completing the lab activity, and quiz your lab partner on the structures of the respiratory system.

- Why does a piece of lung float even after the animal is dead?

- Using the straw, were you able to blow into the lungs through the trachea?

Lab 8
Digestive System of the Cat

This lab examines the digestive system of the cat.

Pre-Lab Activity - Read lab exercise 60a on pages 619-625 in the laboratory manual.

Lab Activity - Follow the listed procedures. Be certain that you identify each part of the digestive system that is listed in the laboratory manual.

Post-Lab Activity - Answer these questions after completing the lab activity, and quiz your lab partner on the structures of the digestive system.

- What structure does the cat have on its tongue that helps it to drink?

- How are the salivary glands similar or different to the endocrine glands?

Lab 9
Urinalysis

In this lab, you will perform a series of tests on your urine. Please note that this lab is not to be used to diagnose medical conditions. You should see a physician if you are concerned about your health.

Pre-Lab Activity - Read lab exercise 63 on pages 651-657 in the laboratory manual, and answer the following questions.

- What is the primary function of the kidneys?
- Why is examining urine useful?
- Name two substances that you should not find in your urine.
- Name and describe the three components of urine.

.

Lab Activity - Follow the listed procedures. Answer the questions in the lab manual and fill out the data table for each of your test results.

Post-Lab Activity - Answer these questions after completing the lab activity.

- If a person drinks a lot of water, what will happen to the specific gravity of his/her urine?
- Name a factor that can alter urine that is not the result of disease or injury?

Lab 10
Urinary System of the Cat

This lab examines the urinary system of the cat.

Pre-Lab Activity - Read lab exercise 64a on pages 659-665 in the laboratory manual.

Lab Activity - Follow the listed procedures. Be certain that you identify each part of the urinary system that is listed in the laboratory manual.

Post-Lab Activity - Quiz your lab partner on the structures of the urinary system.

Lab 11
Reproductive System of the Cat

This lab examines the reproductive system of the cat.

Pre-Lab Activity - Read lab exercise 68a on pages 705-715 in the laboratory manual.

Lab Activity - Follow the listed procedures. Be certain that you identify each part of the reproductive system that is listed in the laboratory manual.

Post-Lab Activity - Quiz your lab partner on the structures of the reproductive system.

Name ______________________________ Section __________ Date ______________

Lab Quiz 1

Answer the following questions with the best answer.

1. Which gland is larger in the young than in adults?

2. A pig's pancreatic hormone might be used to treat diabetes in humans (true/false).

3. What structure in the brain secretes hormones but is not really a "gland."

4. Name the reproductive glands in females and males.

5. Name the gland of the fetal pig that is labeled #1.

6. Name the gland of the fetal pig that is labeled #2.

7. What types of cells are shown in the dissecting scope on your lab table?

8. Name a reason it is important to study the endocrine system of the fetal pig.

9. Which glands are located near the kidneys?

10. Which gland has both exocrine and endocrine functions?

Name ______________________________ Section __________ Date ______________

Lab Quiz 2

Answer the following questions with the best answer.

1. Name two differences between the cat and the pig that you should have seen? (2 points)

2. Name the gland of the cat that is labeled #1. (2 points)

3. Name the gland of the cat that is labeled #2. (2 points)

4. Name the gland of the cat that is labeled #3. (2 points)

5. Name the gland of the cat that is labeled #4. (2 points)

Name ______________________________ Section __________ Date ______________

Lab Quiz 3

Answer the following questions with the best answer.

1. What fluid is the liquid portion of the blood that carries the formed elements?

2. Which of the formed elements is seen in slide #1?

3. Which genetic disorder is seen in slide #2?

4. Which of the formed elements is not a true cell?

5. __________________ is the main oxygen-carrying component in the blood.

6. List the four blood types? (2 points)

7. If the anti-A antibody agglutinates a blood sample, that blood is type _______.

8. A molecule on the plasma membrane of a cell that stimulates the production of an antibody is called a(an) _________________________.

9. What is the primary function of red blood cells?

Name ______________________________ Section __________ Date ______________

Lab Quiz 4

Answer the following questions with the best answer.

1. Using the diagram of the human heart located on your lab table, identify each of the following labeled parts? (1/2 point each)
   #1 ________________________
   #2 ________________________
   #3 ________________________
   #4 ________________________
   #5 ________________________
   #6 ________________________

2. Why is the aorta thicker than the vena cavae?

3. Why are the walls of the left ventricle thicker than the walls of the right ventricle?

4. On the labeled slide, identify which vessel is the artery, vein, and capillary. (1 point each)
   #1 ________________________
   #2 ________________________
   #3 ________________________

5. What condition occurs when the venous valves become weak and no longer work effectively?

6. Where does blood from the pulmonary arteries go?

Name ______________________________ Section __________ Date ______________

Lab Quiz 5

Answer the following questions with the best answer.

1. What is tachycardia?

2. What is the difference between systole and diastole?

3. What instrument measures blood pressure?

4. What is a possible diagnosis if the blood pressure in one arm is different than the blood pressure in the other arm?

5. Elevated blood pressure is called ______________________.

6. What is the general fatigue curve?

7. What does the SA node do?

8. Look at the ECG reading. What does #1 represent?

9. Look at the ECG reading. What does #2 represent?

10. Why is an ECG useful?

Name ______________________________ Section __________ Date ______________

Lab Quiz 6

Using the dissected cat on your lab table identify the marked structures of the cardiovascular system below.

#1 ____________________________

#2 ____________________________

#3 ____________________________

#4 ____________________________

#5 ____________________________

#6 ____________________________

#7 ____________________________

#8 ____________________________

#9 ____________________________

#10 ___________________________

Name ______________________________ Section __________ Date ______________

Lab Quiz 7

Using the dissected cat on your lab table identify the marked structures of the respiratory system below.

#1 ____________________________

#2 ____________________________

#3 ____________________________

#4 ____________________________

#5 ____________________________

#6 ____________________________

#7 ____________________________

#8 ____________________________

#9 ____________________________

#10 ___________________________

Name ______________________________ Section __________ Date ______________

Lab Quiz 8

Using the dissected cat on your lab table, identify the marked structures of the digestive system below.

#1 ____________________________

#2 ____________________________

#3 ____________________________

#4 ____________________________

#5 ____________________________

#6 ____________________________

#7 ____________________________

#8 ____________________________

#9 ____________________________

#10 ___________________________

Name ______________________________ Section __________ Date ______________

Lab Quiz 9

Answer the following questions with the best answer.

1. What substance makes up the majority of urine?

2. What component of urine is the result of protein breakdown?

3. What component of urine is the result of the oxidation of purines?

4. What is the main source of creatinine in urine?

5. How might diet affect urine?

6. If a person drinks a lot of water, what color will his/her urine be?

7. What does specific gravity measure?

8. Why is urinalysis useful?

9. If you have glucose in your urine, what might the reason be? (2 answers, 1 point each)

Name ______________________________ Section __________ Date ______________

Lab Quiz 10

Using the dissected cat on your lab table, identify the marked structures of the reproductive system below.

#1 ____________________________

#2 ____________________________

#3 ____________________________

#4 ____________________________

#5 ____________________________

#6 ____________________________

#7 ____________________________

#8 ____________________________

#9 ____________________________

#10 ___________________________

Name ________________________________ Section ______ Date ____________

Anatomy and Physiology II
Lab Final Exam

Answer the following questions with the best answer. Each question is worth two points.

1. Identify the gland labeled #1, which is from the fetal pig.

2. Why do we use the fetal pig to look at this particular gland?

3. Which glands are located near the kidneys in humans, but are not located near the kidneys in cats?

4. Which gland has both endocrine and exocrine functions and is labeled #2 on your lab table?

5. Name the gland of the cat that is labeled #3.

6. Name the gland of the cat that is labeled #4.

7. Which of the formed elements in the blood is seen on the slide labeled #5?

8. Name all three of the formed elements found in the blood.

9. Which genetic disorder is seen in slide #6?

10. List the four blood types.

11. If the anti-B antibody agglutinates a blood sample, that blood type is _________.

Using the human heart diagram, identify each of the following labeled parts.

12. #7 ____________________

13. #8 ____________________

14. #9 ____________________

15. #10____________________

16. #11____________________

17. Why is the aorta thicker than the vena cavae?

Look at the following slides. Identify whether each vessel is a vein, artery, or capillary.

18. Slide #12 ______________________

19. Slide #13 ______________________

20. Slide #14 ______________________

21. This instrument, used for measuring blood pressure, is called a ___________________.

22. Look at the ECG reading. What does #15 represent?

Using the dissected cat, identify the labeled parts of the cardiovascular system.

23. #16 __________________________

24. #17 __________________________

25. #18 __________________________

26. #19 __________________________

27. #20 __________________________

Using the dissected cat, identify the labeled parts of the respiratory system.

28. #21 __________________________

29. #22 __________________________

30. #23 ___________________________

31. #24 ___________________________

Using the dissected cat, identify the labeled parts of the digestive system.

32. #25 ___________________________

33. #26 ___________________________

34. #27 ___________________________

35. #28 ___________________________

36. How might diet affect urine composition?

37. Why might a person have glucose in his/her urine?

Using the dissected cat, identify the labeled parts of the urinary system.

38. #29 ___________________________

39. #30 ___________________________

40. #31 ___________________________

41. #32 ___________________________

42. #33 ___________________________

Using the dissected cat, identify the labeled parts of the reproductive system of both the male and female.

43. #34 __________________________

44. #35 ___________________________

45. #36 ___________________________

46. #37 ____________________________

47. #38 ____________________________

48. #39 ____________________________

49. #40 ____________________________

50. #41 ____________________________

51. #40 ____________________________

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